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Increasing numbers of inquiries are being received from the various parts of the tropics which can be answered only by persons possessed of an intimate knowledge of local conditions. Enquirers should first satisfy themselves that their local Department of Agriculture is not able to supply them with the desired information before communicating with us. Correspondence which will be replied to is invited on all other matters pertaining to tropical agriculture, science and development.

BANANA RESEARCH.

WHEN the Imperial College of Tropical Agriculture was opened in 1922 one of the first products to attract the attention of the College authorities was the banana. This was perhaps natural since the fruit is not only of great commercial importance but is also extensively produced in the Caribbean area. The need for research was further stressed by the occurrence of Fusarium Wilt, more popularly known as Panama Disease, which was causing a considerable amount of concern both among the growers of the Gros Michel banana, and among the companies connected with the transport and sale of this important West Indian variety. Thus, in view of the alarming spread of Panama Disease, we find that one of the first actions of the staff of the newly opened College was to begin investigations aiming at the control of this disease by the substitution of immune or resistant varieties for the Gros Michel banana. Accordingly a search for resistant varieties was commenced and at the same time, a start was made in breeding work and the raising of new types by hybridization, the banana being normally propagated vegetatively by means of suckers or "bits". Later, in 1926, the Imperial Economic Committee presented their Third Report on Fruit to Parliament, and recommended a Banana Research scheme put forward by Dr. (now Sir) A. W. Hill, Director of Kew. This scheme, with slight modifications was adopted and has formed, during the past years, the basis of the College Banana Research programme. Briefly, the proposals endorsed the breeding work in progress and the collection of varieties, and advised the establishment of a quarantine station at Kew through which all varieties from outside the West Indian area could be quarantined for a definite period in order to obviate the introduction of new diseases from other banana growing regions.

Another feature of the enlarged scheme was the appointment of a pathologist who would investigate the diseases of the banana and of a physiologist whose duty would be to conduct researches into the behaviour of the various varieties during transport and during the ripening period. The enlarged scheme which envisaged the provision of cold storage facilities has now been functioning for about three years since, thanks to the Empire Marketing Board, funds have been forthcoming, both for the recurring expenditure on the two scientific officers and their establishments, and for the capital expenditure on a carefully organised and equipped Low Temperature Research Station.

The results of these investigations have been published from time to time by the Empire Marketing Board in their series of Bulletins* and form a valuable record of the information that has so far been added to our knowledge of the problems connected with the banana industry. During the course of extensive tours both the pathologist and the physiologist have recorded their opinion that the problem of Panama Disease is very complex. They have brought out clearly that this disease is by no means the only factor and that the causes of abandonment of so many areas in the last few years, apart from destruction by the Panama Disease organism and the planting of diseased material, are adverse soil conditions, which include sourness due to lack of drainage ; unsuitable soils ; and soil deterioration which, in the absence of good husbandry and intelligent treatment is very rapid in the tropics. They have also pointed out that the cultivation of the banana has far too frequently been conspicuous by its absence. Quite apart from these observations, however, the conclusion has been arrived at, and it has now generally been accepted, that the best way of combating the disease is by the substitution of immune or resistant varieties for the universally grown Gros Michel.

The publication of a progress report by Professor Cheesman which records the results of the breeding work carried out at the Imperial College of Tropical Agriculture in the last nine years, is therefore all the more welcome. A perusal of this report gives one some impression of the fascinating nature of the work that is being attempted and of the great difficulties that have to be overcome. When it is remembered that all commercial bananas must of necessity be seedless, the difficulties involved in the production of a new variety will immediately become apparent since to achieve this it will be necessary to cross the commercial type with a wild or semi-wild type possessing seeds and then to breed the seed out of the resulting cross in order to make the new type suitable for commerce. The small number of seeds obtained makes progress slow, but about half the varieties in a collection of eighty have shown themselves capable of producing seed. Considerable progress is, however, recorded in this report. The work has involved much laborious cytological study but it has indicated that the possibility of rearing sterile bananas from fertile wild bananas is by no means remote. A collection of bananas has been made from all parts of the world and not the least valuable section of the investigations has been the classification of these varieties into groups and sub-species. The same variety has often many *aliases* in different parts of the world and the orderly relegation of the numerous so-called varieties into their real groups should prove of great value to future workers.

Reference must now be made to the investigations on the transport and storage of the banana. Several varieties have already been tested with success for immunity or resistance to Panama Disease and the next step has been to try out their possibilities as commercial fruit with a view to the replacement of the Gros Michel. The results of some of these tests which have been recorded by Dr. McGuire and Dr. Wardlaw indicate that a type of Cavendish known in the West Indies as the Governor Fig has distinct possibilities as a commercial fruit, provided the storage temperature and conditions are carefully regulated to suit its requirements. Other varieties tested have on the whole proved somewhat disappointing.

Another aspect that has received particular attention is the damage caused to the fruit during transport by fungal and bacterial attack. The feasibility of the control of such a disease as Stem End Rot has been demonstrated. Cooling, without danger of chilling the fruit, may be much more rapidly effected than was popularly believed. Rapid cooling has also the great advantage of retarding fungal activity and decreasing wastage of fruit during a voyage.

In conclusion it may be conceded that the banana research work at the College has already been productive of results that are proving of value to the industry. Good progress has been made in the breeding work, which, however, is definitely long range research and it is only by patient investigations and accurate cytological observations over a series of years that final success can be expected. The scheme as a whole is of interest as illustrating the successful application of team work on the part of scientific officers in an attempt to elucidate a problem of first class economic importance.

* *E.M.B.*, 36 ; *E.M.B.*, 45 ; *E.M.B.*, 47.

CONSULTING SUGAR TECHNOLOGISTS.

We have learned that Mr. W. Scott and Mr. R. G. W. Farnell have entered in partnership, some months ago in London, as Technical Advisers to the Sugar Industry with offices in Trinidad and London as "Scott Farnell and Partners." Both principals have been closely associated with the College from its early days.

Mr. Farnell, a son of Dr. R. L. Farnell, once Vice-Chancellor of Oxford University, came to Trinidad in 1923 as Research Chemist of the British Sugar Research Association. He did much of his work, here, in a laboratory provided by the College. In later years he has been particularly interested in the production of white (refined) sugars and syrups in both the cane and beet sugar industries.

Mr. Scott has had considerable practical experience in Louisiana, Cuba and Trinidad in the production of most grades of sugar ; also in the design of modern sugar factories, refineries and special machinery. He was Professor of Sugar Technology at the College from 1925 to 1931, as well as Technologist of Usine Ste. Madeleine and Technical Adviser for two other Sugar companies in Trinidad.

Both Mr. Scott and Mr. Farnell have had exceptional facilities for extensive travelling throughout the Sugar World ; and we feel certain that their many friends in the sugar industry will join us in wishing them success in their wider sphere of activities.

PLANT PROPAGATION.

The Propagation of Tropical Orchard Crops at the Union Agricultural Station, St. Lucia.

By E. A. Walters, F.R.H.S., F.R.M.S.

Introduction.

Recent developments in the fruit trade between Canada and the West Indies have stimulated St. Lucia, like other islands in the Caribbees, to develop and expand her fruit industry. St. Lucia, in this respect, is particularly favoured, as she not only enjoys great natural advantages through her situation and harbour facilities, but also possesses a genial climate and a fertile soil, much of which still remains untilled. One of the first steps taken by the Colony's Department of Agriculture was to open, in May, 1928, a new Agricultural Station, which has specialised in the intensive propagation of mangoes, avocado pears, and pineapples, and the following article describes recent advances in respect of this work.

Mangoes.

Propagation of the choice mango, *i.e.*, Julie, by the approach graft, is standardised in the West Indies, but failures are frequent, as with this method the plant must be kept under nursery conditions for about four months and special care must be given during this period. Reduplication can readily be obtained by top-working and also by budding on young stocks.

(*i*) *Top-working Mangoes.*

This, within two years, offers a ready means of transforming established and wild trees into fruit-bearers *in situ*. The method is now in regular practice in St. Lucia and has stimulated the demand for experienced propagators to work common trees on estates.

Any well-grown mango can be prepared for top-working by felling the tree carefully at about four to six feet above ground, leaving an intact, sloping surface, preferably facing north. Branches, if found low down, can also be prepared instead of the main trunk, the cut surfaces being painted with a suitable wood preservative such as solignum, tar, or paint. If no young shoots are present, suitable ones will arise within two months. Three to five of these should be selected, evenly spaced around the stump, and the remainder pruned off. The shoots are ready for budding as soon as they begin to suberise or form cork. This can be detected by the change in colour of the shoots from green to brown, by the scabrous exterior, and frequently by the presence of a distinct eye (the bud) outlined by the brown cork layer.

The scion bud is selected from shoots of a similar degree of maturity, from a tree of the required variety, and can readily be removed by peeling off a piece of bark containing a bud, which should come away clean without any adhering pieces of wood or fibre.

For budding, a suitable place should be chosen low down on the young shoot for insertion of the bud. An inverted T-shaped cut is made; one and a half inches long and half an inch wide; and the flaps of bark are carefully loosened up with the bone end of the budding knife. The strip of bark containing the scion bud is now lifted, trimmed to fit, and immediately inserted and pushed well up into the "handle" of the cut. The upper edges of the incision will hold the bud, but the lower ones should be carefully carved away to allow the bud to rest in a Λ-shaped opening. This is, in turn, firmly tied in with raffia, and the top of the shoot ringed half an inch wide so that the cell sap may concentrate around the bud. Within a week or so, budded trees should be examined, loosened, retied, and disbudded as necessary. In three months the buds make quite stout heads, which should be pruned back to encourage wood formation at the union, and so to prevent wind-blown heads.

(*ii*) *Approach Top-working.*

Where grafted mangoes in pots are available, a direct graft into the prepared stump can be made which gives a strong head in three to five months. A clean strip of bark is first removed from the tree so as to accommodate the introduced stem (scion). This, after being pared to expose the cambium layer, is then fitted neatly into the channel prepared for it and wedged firmly into place by a copper or zinc nail driven through the graft. The operation is completed by sealing any exposed surfaces with grafting wax. The grafted plant should then be partially severed below the new graft area, by a deep cut in the original graft, and eventually removed as the new union is completed. Watering is necessary until removal, and the grafted plants in pots may be used again when sufficient growth is made for approach or planting out.

(*iii*) *Budding.*

This is a similar operation to the inverted budding described above, the stock being about two feet high and showing a brown-green mottling of the bark. Mango "Long" affords the best stock and should be selected from germinated seeds in order to remove any polyembryonic seedlings.

The mango bud is unique in its method of union with the stock plant, cohesion taking place only under the bark and not at the sides. The bud is thus found to be carried upwards on the cushion formed of rapidly dividing cambium cells. To check this activity and induce the formation of wood (xylem), pruning is resorted to as the bud-shoot develops a branch system. Another necessary operation to ensure successful budding is to carve off the superimposed bark, to prevent the wound-gum, from cells in the upper edges of the cortex, filtering into the space at the back of the bud, and thus preventing a union. Mangoes exhibit some diversity in fruiting habits, both with regard to the area of the tree occupied

by the crop, and the seasonal variation, as influenced by weather conditions, which sometimes results in an early or late crop in one season, followed by a barren period. Flowering and subsequent fruit formation has been induced by smudging, *i.e.*, using smoke fires beneath local common mangoes. Severely smoked branches develop shoots and subsequently set fruit. This has not been tried on grafted mangoes in St. Lucia, but they appear to have been experimented with in Panama* with some success.

Immunity, both to blossom disease and fruit anthracnose, is a very desirable feature of the Julie variety.

Avocado Pears.

Propagation of these is an easy matter; the choice of suitable stocks and scions is, however, more difficult, as the varieties available are somewhat mixed, although useful types have been introduced from Florida and Porto Rico. The desirable characters in St. Lucia are, for a stock, a robust root and stem system, and resistance to root disease, and to drought, which may cause fruit fall; and for scions, the absence of die-back on young branch tips.

(*i*) *Propagation by Wedge-graft.*

This method consists of the insertion of a wedge of soft shoot into a cleft stem. After the avocado seeds have been carefully selected, they are washed, and bedded in the greenhouse floor beds for germination. The best plants are potted immediately on germination, and allowed to develop for about two weeks. The plumule, which is then about six inches to eight inches long, carries scale-like leaves and is a soft, dull red, watery shoot, composed of meristimatic tissue. To graft, the shoot is beheaded at five inches and a fork is formed by slitting the stem downwards for one inch, into which is firmly pushed a tapered, soft shoot of the selected variety, freed from foliage or flower buds. The whole is then carefully tied into position with raffia, and the plant is watered and kept in a cool place. The graft is examined after five days, when the raffia should be gradually loosened and finally removed, to allow of free development. To prevent "sleepiness" on the part of the grafted plant, the soil should be watered with a solution of sulphate of ammonia, and later top-dressed with a complete manure. Practically no losses are to be feared from this method.

(*ii*) *Late grafting.*

This is a development of the above method, except that plants and not seeds are grown in beds for subsequent selection and replanting in nursery beds for grafting. For this purpose, plants can either be collected and improved, or seeds germinated and planted in readiness. The plants can be grafted as soon as the swelling of the buds gives evidence of new root activity. The upper three inches of soft growth is cut off, and a wedge of a fairly firm green shoot is inserted and tied as before. This operation is successful where light shade is available and growth conditions are good. For producing shorter grafted plants where stocks are drawn and etiolated, a side-saddle graft can be made by inserting the wedge-scion sideways at a suitable height and closing the graft with raffia, followed by removing only the soft head of the stock to localise growth nutrients around the graft. Subsequent treatment follows the usual procedure, the stock being pruned back to the union when this is satisfactory, while the cut ends are painted with Agrisol-preservative or white paint. The method of late-grafting or side-grafting is applicable to cut-back trees, and these can be successfully top-worked if care is taken to seal the stump surfaces with paint or tar.

When required urgently, avocados can be readily branch-grafted and bottle-grafted for the production of special varieties. This method is an adaptation of the approach-graft, using bottles or test tubes of water to keep the branch scions fresh and active. Wild trees lifted for a few pence from peasant gardens were, in this manner, transformed into special varieties, and flowered in the second year of transplanting.

The double-grafting of special varieties imported as seeds, although it cannot be recommended as a standard practice, has been attained by grafting mature wood of a local variety into the stock from an imported seed, the resultant plant being again grafted with the apical shoot of the imported variety in an endeavour to induce early fruiting so that any desirable fruiting qualities may soon be recognised.

Pineapples.

(*i*) *A New Method of Pineapple Propagation.*

The following method of pineapple propagation was worked out by the writer during the latter half of 1929, and up to the present has given excellent results. It promises to supersede the standard method of de-suckering lateral growths for making new material, as it produces a larger number of uniform plants of a given variety within a short time.

The pineapple plant, preferably before the formation of the fruit stem, is stripped of all leaves except the last six or so which form the rosulate young shoot. The rhizome and aerial stem, when freed from roots and scales, is then cut with a sharp knife into clean cross-sections not more than one-fifth inch thick. Such sections, which will carry from three to four, more or less dormant, buds, should be put into a two to five per cent. solution of potassium permanganate for about ten minutes, after which they should be removed and allowed to drain. They are then planted in a flat position on a prepared bed of light soil, or, if a solar frame is available, on a bed composed of chopped coconut fibre and granulated charcoal, covered with a thin layer of soil or fibre, and watered.

* *Annual Report*, Canal Zone Plant Introduction Gardens, 1928.

FIG. 1.—*Vegetative propagation of pineapples by the sectional method. Five stages (from left to right) : (a) prepared rhizome (b) prepared circular section (c) ¼ sections germinating, note that sections have been soaked (d) later stages (e) complete plantlet.*

FIG. 2.—*Pineapples—sugar loaf variety raised from sections, 16 months old, height 2 feet 4 inches.*

FIG. 3.—*Showing grafting by approach method (Julie mangoes).*

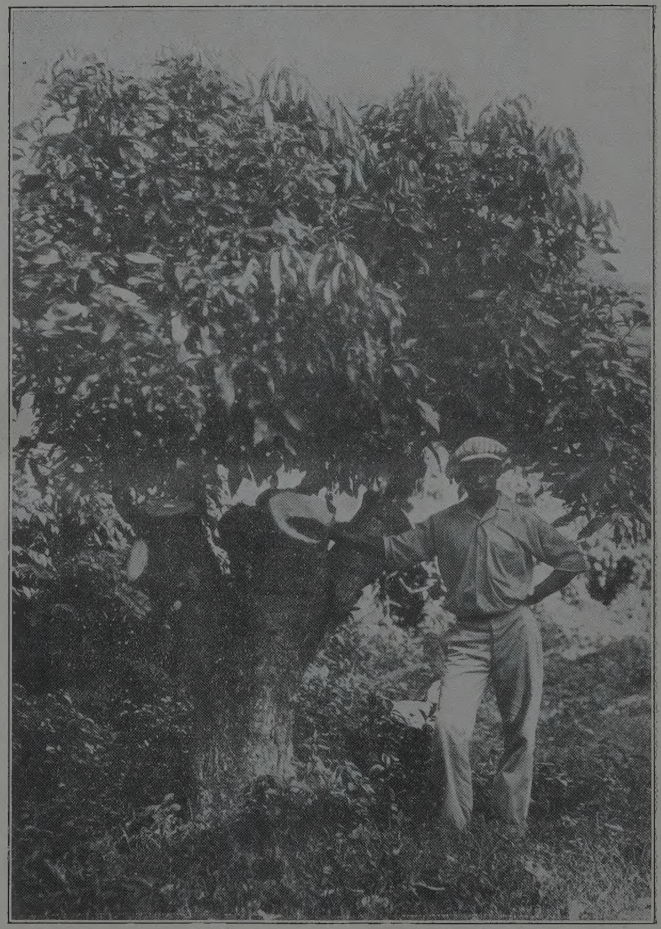

FIG. 4.—*Top worked mango—budded Julie variety—18 months old.*

Germination of the dormant buds takes place within a week or a fortnight, according to the bed temperature maintained and the pineapple variety. When the buds have formed shoots, the section is lifted (care being taken to retain any embryo root system) and is severed in three triangular portions, each with its own bud. The sections are then re-dipped in the permanganate solution, re-planted in the germinal bed, and watered with a solution of ammonium sulphate. Within a short time the embryo pineapple plants, with a good root system, can be transferred to an outside bed or further advanced in the greenhouse in manured beds. Only moderate watering is necessary, but free use should be made of fibrous material (chopped coir) and dressings of cotton-seed meal or similar complete manures. The stem end may also be dipped in permanganate solution and embedded in the chopped fibre, where it roots readily. The permanganate solution is used to prevent the growth of destructive organisms.

The object of using unfruited stems is to take full advantage of the food reserves present, of which each bud is allotted a share in sectioning. Furthermore, the buds, being stimulated by moist heat and by flooding with the nutrient solution, can develop a root system before decay sets in. Subsequently, the triangulate scrap of stem is almost completely re-absorbed, leaving behind only the fibrous remains of the vascular bundles intimate with the root system. It should be observed that water and gaseous exchange takes place only with difficulty through a cork membrane, thus the passage of these substances must occur mainly through the cortex at the cut ends of the sections, and care should be taken not to bruise these areas when cutting sections for germination.

The development of flower heads in maturing pineapple plants required for propagation may be prevented by a drop of weak sulphuric acid tubed into the centre of the expanding bud.

(*ii*) *Subsequent Treatment of Young Plants.*

From mature stems of one foot in length, from 80 to 100 plants may be obtained within six months, ready for setting out in nursery beds. Diligent manuring may be practised with the young plants, which respond vigorously to dressings of cotton-seed meal. It is not expected that such plants will behave any differently from the side-shoots and suckers tardily developed in the normal flowering and fruiting plant, or that they will not carry satisfactory fruit characters. Also, in view of the fact that the young buds are isolated from the parent before the pre-fruiting period of dormancy sets in, they should develop into fruit plants equal to, or better than, the parent forms. This is suggested by the behaviour of injured main stems, unable to fruit, but which develop a crowd of suckers each endeavouring to fruit but failing to do so owing to starvation. Most rhizome-bearing plants would appear able to reproduce themselves when treated in this manner; ginger, for instance, produces large numbers of plantlets when buds are isolated and suitably manured. In propagation work of this kind, the main object is to induce the plant to re-direct its energy wholly to the continuous production of meristematic tissue.

As seen very clearly in the Java water-sucker method of cane variety propagation, a normal single-bud shoot or cutting can be made to produce many buds by checking the formation of leading shoots as fast as these develop. This is done by lifting, dividing and re-planting the bud-bearing cutting, with the leafy shoots pruned back and covered flat in the propagating bed. This is far quicker than waiting for mature cane cuttings whereon the single bud has become dormant and slow to respond. By this method, important and scarce varieties may be rapidly propagated from one introduced cutting, while the danger of importing large numbers of possibly diseased cuttings is avoided. The writer introduced one cutting of P.O.J. 2878 late in 1928, and this variety is now established at three sugar factories and is still available in quantity. Probably about 500,000 effective plants could now be obtained if all stools were divided and re-planted. This method can be successfully practised on the sugar estates.

Summary.

A description is given of certain methods of propagation, used in St. Lucia, of mangoes and avocado pears, and also of a new method, evolved in St. Lucia, for the propagation of pineapples. It is proved that the use of actively budding tissue, provided with ample supplies of water and plant food, gives very encouraging results.

NEW LIBRARY ACCESSIONS.

ENTOMOLOGY AND ZOOLOGY.

Amyot et Seville. Hemiptères. *Librairie Encyclopédique de Roret,* Paris, 1843. Second hand copy, $10.

Escherick, K. Die Forstinsketen Mitteluropas. 3 Vols. *Paul Parey,* Berlin, 1914, £4 15*s.* 3*d.*

Imms, A. D. Social Behaviour in Insects. *Messrs. Methuen & Co. Ltd.,* London, 1931. 21*s.*

Meyrick, E. Exotic Microlepidoptera, Vol. IV. Pt. 1. *Taylor & Francis,* London, 1930. 3*s.*

Norman, J. R. A History of Fishes. *Ernest Benn,* London, 1931. 28*s.*

Zacher, F. Die Vorrats, Speicher und Materialschadlinge und Ihrebekamfung. *Paul Parey,* Berlin, 1927. 10 Marks 40.

GENETICS.

Fisher, R. A. The Genetical Theory of Natural Selection. *Clarendon Press,* Oxford. 17*s.* 6*d.*

TRINIDAD FUNGI.

Copies (price 2*s.* each) of a list of TRINIDAD FUNGI compiled by C. A. Thorold can now be obtained on application to the Editor of this Journal.

ACCURATE MILLING CONTROL.

The Importance of Weighing the Bagasse for Accurate Milling Control.

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I.—Introduction.

THE basic milling control equation is:—
Weight of Cane + Weight of Maceration Water = Weight of Mixed Juice + Weight of Bagasse . . .(1).

This equation can be made to balance only when the four quantities are weighed *immediately* before entering or leaving the mill. If any three are weighed under these conditions, the fourth presumably can be accurately estimated, but should even a short interval of time be allowed to elapse before weighing, the balance of the equation become seriously disturbed. This fact may be illustrated by the results of an experiment which was conducted at the College factory. It was found that the loss in weight of a load of cane after dumping in the mill-yard, and exposure to the weather for five hours, resulted in a loss of 2.8 per cent. of its initial weight. In view of this result, an attempt was subsequently made to determine the effect of the loss in weight on the milling control of the factory.

The capacity of the sugar factory at the College is small, the cane consumption being only 2.75 to 3.00 tons per hour. The mill grinds ten hours a day during the crop season, and it is usually necessary to leave the canes in the yard from one grinding day to the next.

It was not found possible to weigh the canes immediately before grinding, mainly because of transport difficulties and factory irregularities which imposed a delay of average duration eight hours and maximum duration of twenty hours. Both the maceration water and the mixed juice can be weighed immediately they enter or leave the mill. In order to obtain all the weights represented in the equation, plans were made for weighing the bagasse. This was undertaken for a routine period of approximately three weeks. When once the operator had gained experience of the use of the scale, the system worked easily, and the furnace was adequately supplied with bagasse fuel.

II.—Methods employed for obtaining the Weights of the Materials entering and leaving the Mill.

Chemical control in the factory is based on actual or calculated weights of materials entering and leaving the mill, and losses and recoveries are calculated from the weights and analyses of these materials. It is therefore important that such weights be highly accurate. Methods used for obtaining the necessary factory data vary in different factories: the weight of the cane may be merely estimated (*e.g.*, by measuring the draught of the punt, as in some factories in British Guiana), or the juice may be indirectly measured by the number of clarifiers filled.

1. WEIGHT OF CANE.

The weight of cane is determined either in the field, in the yard, or immediately before the truck is unloaded into the cane carrier. The latter method is the most desirable from the point of view of accurate factory control. The dependability of the weight obtained varies with the type of scale employed. The platform beam type (in which the beam is balanced by hand), is probably the most commonly used. The platform should be large enough for all the wheels of one truck to rest upon it at any one time, but not so large as to take two or more trucks. The larger or "batch" type of weighing machine does not give uniform results when a truck is shifted from one part of the platform to another. Radersma (1) criticized the methods used in Java on this score, but accepts an accuracy of 2 per cent. He points out that an over sensitive beam demands too much of the operator's time, and that the system in which the trucks roll slowly and continuously over the platform, the weight being obtained from an indicator, does not yield sufficiently accurate results. The observed weights are usually too high. There are several errors, therefore, in the simple weighing of a truck of cane, and it is difficult to judge the degree of accuracy of any one method unless a truck is carefully reweighed in the absence of disturbing factors.

2. WEIGHT OF MACERATION WATER.

The weight of maceration water may be obtained (*a*) by direct weighing, (*b*) by measurement in a tank of known capacity, or (*c*) by calculation. With the first and second methods, complications arise when the water is weighed warm, since corrections for weight of vapour lost must be applied to the daily totals. The most desirable method is to weigh the cold maceration water.

The weight of maceration water cannot be determined accurately by calculation. A maceration factor has to be obtained, and the weight of maceration water for the mill balance calculated from the dilution water (which is derived from the Brix of the normal juice, the Brix of the mixed juice, and the weight of the mixed juice). The accuracy of this calculation depends, in turn, on the accuracy of the normal juice factor. The College sugar factory is equipped for weighing cold maceration water, and the variation in the maceration factor from day to day may therefore be determined by calculation. During the crops of 1930 and 1931, the value obtained varied between 0.39 and 0.95, with an average for 1930 of 0.71, and for 1931 of 0.61. Even from one day to the next with cane ground from the same field, the maceration factor varied over a relatively wide range. There is no reason to believe that such variation is peculiar to the College factory. For accurate mill control, therefore, it appears desirable to employ a maceration water scale. A fairly accurate estimate of the weight of maceration water may be obtained by means of a calculation presented by Deerr(2). The weights of cane and of the mixed juice alone are necessary,

so that, by abstracting these two weights from the weekly reports of the factory for crop 1930 and proceeding according to Deerr's method, the calculated maceration factors could be compared with the actual maceration factors. The results are set out in Table I.

Table I.

MACERATION FACTORS, I.C.T.A. CROP 1930.

	Calculated Factor.	Actual Factor.
Run No. 1	0.61	0.62
2	0.65	0.67
3	0.76	0.79
4	0.74	0.76
Mean	0.68	0.71

3. WEIGHT OF MIXED JUICE.

The importance of an accurate estimate of the weight of mixed juice is almost as great as the importance of accurate "weight of cane" and "weight of sugar" figures. Crude methods (such as measuring the juice hot in the clarifiers and correcting for temperature) are gradually being eliminated by the introduction of automatic weighing machines. Calculation of the weight of mixed juice from its measured volume is undesirable because of the known errors in measurement. Even if the operator correctly counts the number of tanks filled, other discrepancies arise, such as those introduced by occluded air, by the difficulty of estimating the depth of foam, and, with tanks not fitted with sloping bottoms, by stagnation of the thick bagacillo deposit. Unless the capacity of the juice measuring station is sufficiently great, the first discrepancy cannot be eliminated; it may indeed be aggravated when liming and measuring are performed in the same tanks and when compressed air is used for stirring. The second and third discrepancies may be overcome by the use of suitably designed tanks.

An accurate figure for the weight of mixed juice may, however, be obtained by the use of special scales. Some of the types are automatic in action, and are highly efficient. Moreover, the cost of their operation is as low as that involved in measuring the juice, and considering the service obtained, the capital investment is negligible.

4. WEIGHT OF BAGASSE.

Whatever methods be used for obtaining the weights of cane, mixed juice and maceration water, the weight of bagasse is usually obtained by difference. The accuracy of the result is necessarily dependent, however, on the accuracy of the other three weights. In very few cases only is the weight of bagasse obtained directly, in spite of the fact that it provides a check on the other figures. Errors in weighing the bagasse affect such figures as Pol per cent. Cane, Fibre per cent. Cane, Pol Extraction &c., but it is not often possible to determine the error, although the milling figures may appear to be quite normal. In most factories, the weighing of bagasse is a very necessary operation, but its need is not so urgent when maceration water, mixed juice and freshly delivered cane are weighed.

III.—Equipment used and Results.

The canes received at the College factory are weighed on a POOLEY, 6,000 lb. platform scale, and then dumped in the yard prior to hand-feeding to the cane carrier. The procedure may be compared with the practice in larger factories where the cane is weighed as it enters the mill-yard, and where the trucks are kept in sidings until they are emptied into the carrier.

The mixed juice is weighed in the College factory in bin scales supplied by A. & T. AVERY. The capacity is 550 lb. juice, and gross and tare weights are recorded for each bin. The scales are checked every three days, but very little change is usually noted once they have been initially adjusted. The same type of equipment is used for weighing the cold maceration water, as well as the last mill juice when necessary.

The bagasse is weighed in a special machine supplied by S. DENISON & SONS. It is a beam type, with container mounted on a platform. At the top of the bagasse elevator is a hopper of sufficient capacity to allow the weighing and emptying of a full scale load, without the hopper becoming full. The container, in cross section, is the shape of a right angle triangle, whose short, uppermost and horizontal side forms the top, and is open to receive the bagasse from the hopper. The next longest and vertical side forms a door which facilitates rapid emptying; the hypotenuse forms the steep sloping bottom. The machine is efficient and, apparently, gives accurate results. It would probably have to be modified and enlarged if greater quantities of bagasse were to be handled. Table II sets out the total weights recorded during twenty-one grinding days of the 1931 crop.

An examination of this table shows that the weight of bagasse obtained by weighing (column (4)) and the weight obtained by difference (column (5) *i.e.*, weight of cane+weight of maceration water−weight of mixed juice) never coincide. The discrepancy is shown in column (6), and is due to the fact that any alteration in the weight of cane between the time of weighing and the time of grinding either increases or decreases the apparent weight of bagasse in accordance with the equation. In most cases, the weight of bagasse is artificially increased because the cane loses weight during storage in the yard previous to grinding. The loss in weight depends mainly on the time of exposure and on the temperature and humidity of the air. An increase in weight would occur in wet weather. It is interesting to note that when the canes remain in the yard over a

week-end (*e.g.*, Crop Days 17, 25, 31) the difference is large. Other high differences may be explained by the fact that relatively large quantities of cane are occasionally held over from one day to the next.

Table II.

Date.	Crop Day.	Tons (by weighing). (1) Cane.	(2) M. Water.	(3) Mixed Juice.	(4) Bagasse.	(5) Bagasse by Difference. ((1)+(2))-(3)	(6) (5)-(4)
25th March, 1931	13	25.878	3.627	22.732	6.436	6.773	0.337
26th March, 1931	14	27.906	4.917	24.074	6.143	8.749	2.606
27th March, 1931	15	22.709	3.886	20.369	4.676	6.227	1.551
28th March, 1931	16	17.454	1.551	14.394	4.983	4.611	– 0.372
30th March, 1931	17	25.206	5.185	23.299	4.575	7.092	2.517
31st March, 1931	18	28.938	4.071	24.116	4.961	8.893	3.932
1st April, 1931	19	17.583	3.112	15.297	2.678	5.398	2.720
			Easter	shut down.			
7th April, 1931	20	20.133	4.172	20.413	3.293	3.892	0.599
9th April, 1931	22	26.996	5.140	23.725	4.799	8.411	3.612
10th April, 1931	23	28.952	6.086	27.867	6.186	7.171	0.985
11th April, 1931	24	15.135	3.589	14.666	3.999	4.058	0.059
13th April, 1931	25	32.055	4.324	27.613	6.441	8.765	2.324
14th April, 1931	26	30.149	5.359	27.081	5.903	8.427	2.524
15th April, 1931	27	23.093	3.545	21.686	5.692	4.952	–0.740
16th April, 1931	28	27.822	3.863	23.186	5.892	8.499	2.603
17th April, 1931	29	22.526	3.866	20.001	5.061	6.391	1.330
18th April, 1931	30	16.898	2.582	14.352	4.165	5.128	0.963
20th April, 1931	31	27.299	5.190	24.706	6.516	7.783	1.267
21st April, 1931	32	28.824	5.797	27.541	6.044	7.080	1.036
22nd April, 1931	33	28.550	4.494	25.468	6.496	7.576	1.080
23rd April, 1931	34	26.711	4.703	24.655	6.989	6.759	– 0.230

The Daily Reports of the factory are calculated on the basis of "weight of cane+weight of maceration water−weight of mixed juice=weight of bagasse". During the bagasse weighing run, Fibre per cent. Cane, Pol per cent. Cane and Pol Extraction were calculated on the basis of "weight of bagasse+weight of mixed juice−weight of maceration water=weight of cane". These results, obtained in actual factory runs, are set out in Table 3.

Table III.

Crop Day No.	From weight of Cane. Pol % Cane.	Fibre % Cane.	Pol Extraction.	From weight of Bagasse. Pol % Cane.	Fibre % Cane.	Pol Extraction.
13	12.78	13.12	90.69	12.73	12.63	91.10
14	12.68	15.97	90.49	12.33	12.37	93.13
15	14.23	13.42	90.82	13.91	10.82	92.97
16	13.93	13.52	90.40	14.04	14.30	89.67
17	13.25	14.55	91.92	12.89	10.42	94.51
18	13.41	15.45	90.29	12.85	9.99	94.24
19	13.80	15.32	90.15	13.11	8.98	94.88
20	16.65	9.62	95.29	16.54	8.39	95.97
22	14.85	15.13	90.80	14.27	9.96	94.53
23	15.38	12.78	94.54	15.27	11.41	95.18
24	14.51	13.31	92.90	14.43	13.16	93.40
25	13.64	13.79	92.11	13.35	10.92	94.06
26	14.20	13.78	93.14	13.91	10.54	95.08
27	14.70	10.30	93.08	14.85	11.47	92.13
28	13.41	15.11	89.89	12.98	11.55	92.50
29	13.90	13.96	91.37	13.65	11.75	93.03
30	13.11	14.87	90.38	12.87	12.80	92.05
31	14.83	14.05	92.02	14.64	12.33	93.24
32	13.43	11.41	92.62	14.34	10.10	93.61
33	14.87	13.15	91.90	14.69	11.67	93.04
34	16.30	12.54	92.63	16.34	12.86	93.34

Owing to the much higher percentage of Fibre in Bagasse than Pol in Bagasse, the Fibre per cent. Cane is affected to a larger extent by this recalculation than the Pol per cent. Cane or Pol Extraction.

Figure 1 is a graph showing the Fibre per cent. Cane from day to day when calculated by each of the two methods. The figures for Fibre per cent. Cane as calculated from the weight of bagasse, on the whole, do not fluctuate to such an extent as those for Fibre per cent. Cane calculated from the weight of cane. This is because the varying losses in weight of cane between the time of weighing and the time of grinding have been eliminated. It is statistically impossible to obtain a representative sample of cane for fibre analysis, unless large quantities are used, and it seems that, except in the case when the cane is weighed immediately before being unloaded on to the carrier, the best method of obtaining the Fibre per cent. Cane figure is to calculate it from the actual weight and the analysis of the bagasse. The weighing of bagasse on a really large scale is somewhat difficult, and might possibly be most efficiently carried out by the use of duplicate scales.

Incidentally, the weighing of bagasse under the conditions that obtain at the College factory is of extreme importance, especially when cane is purchased from farmers on a Pol or Sucrose basis. Should there be a period of lag between the time weighing and the time of grinding, the Pol per cent. cane as determined by the method of difference, is too high, and therefore the price paid by the factory for the cane becomes excessive. This point is illustrated in the following paragraph.

Irrespective of deterioration losses and taking into account only the Tons of Pol or Sucrose estimated in the mixed juice and bagasse, the Pol or Sucrose per cent. Cane paid for by the factory is estimated by :—

$$\frac{(\textit{Tons Pol in Bagasse} + \textit{Tons Pol in M. Juice}) \times 100}{\text{Tons Cane.}} \times \text{Overall Recovery, \&c.}$$

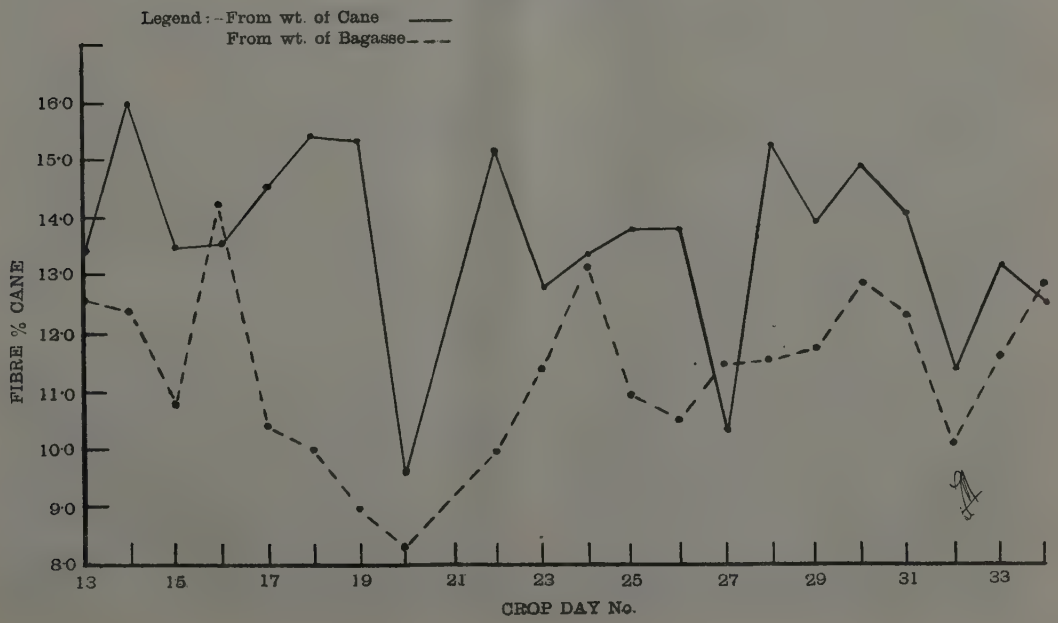
Assuming the difference to amount to but 0.1 available 96° Pol per cent. Cane, *i.e.* say, 10.00 instead of 10.10 (*see* table 3), the farmers of Trinidad produced, in 1931, 385,000 tons of cane, and therefore they would have been paid the value of approximately 197 tons of sugar too much, not because of inaccurate sampling and analyses, but because the weight of cane received and recorded by the scale and the weight ground at the mill were not identical, and this deviation has produced a further error in the weight of bagasse, making the Tons Pol in bagasse too high in the above formula.

IV.—Conclusions.

The investigation recorded above indicates that the loss of weight in cane obtained between the time it is weighed and the time it is ground results in serious errors in the milling control figures. Assuming that the weights of maceration

FIGURE 1

FIBRE % CANE



water and mixed juice are accurately estimated, these errors may be rectified by one of two methods either (*a*) the cane must be weighed *immediately* before it is ground, or (*b*) the bagasse must be weighed. In the case of the second alternative it would still be necessary to record the weight of cane delivered, and the sooner the cane is ground after weighing, the smaller will be the difference between the totals of the two sides of equation (1). From a purely factory point of view, cane analyses and milling figures should be calculated on the basis of the right hand side of the equation (*i.e.*, weight of bagasse+weight of mixed juice —weight of maceration water) since, by obtaining the weight of cane by this method, all losses in weight up to the time of grinding are eliminated.

These remarks apply to factories in which the canes are not weighed immediately before unloading onto the carrier. When canes are weighed at this stage, a bagasse scale would be of use mainly as a check on the figures.

Bibliography.

1. Radersma.—*I.S.J.* (1930), p. 136.
2. Deerr.—"Sugar-Cane" Second (Revised) Edition, p. 553.

PAPER MAKING.

(*The following note is abstracted from a book* review by Prof. E. F. Armstrong which appeared in the 5th December, 1931, issue of "Nature".*)

The use of grasses and bamboo as a source of raw material for paper making is certain to extend as the supply of wood pulp becomes less assured. The slow growth of trees makes it difficult, if not impossible, to maintain the supply of wood pulp, and the comparatively rapid growth of bamboo renders it important from the point of view of continuity of supply.

The digestion and bleaching of bamboo cellulose requires a different technique from that of wood pulp, and, after twenty-five years study of the subject, Mr. Raitt has solved most of the difficulties and has made it possible to utilise bamboos of all ages. The digestion process takes only five hours, giving a yield of 42 per cent. of bleached pulp, and its simplicity compares favourably with the current methods for wood pulp.

The rapidity with which the consumption of paper is rising, and the increasing demand for cellulose as a raw material for other industries, (particularly artificial silk), is alarming when compared with the world's potential supply of wood pulp, but this book shows that the solution of the problem has passed the empirical stage. With careful exploitation, the supply of cellulose from bamboo could be maintained at an almost inexhaustible level.

* The Digestion of Grasses and Bamboo for Paper Making. By W. Raitt. *Crosby Lockwood & Son*, London, 1931; pp. xi+116+20 plates. Price 21*s*.

REVIEWS.

AGRICULTURAL POLICY IN SOUTH AFRICA. By H. D. Leppan. *The Central News Agency, Ltd.*, Johannesburg, South Africa. pp. 101, price 6*s*.

This book represents a short survey of the problems which at present confront the agricultural industry of South Africa. The author discusses in turn the farming situation, agrarian policy, and the lot of the South African farmer. Particular prominence is given to the natural advantages and disabilities of the country. Of the latter there appear to be many but the author thinks that the disabilities connected with moisture are the chief limitations to South African farming. Also "the diversity of South African conditions spread from arid to humid country; from the cultivation of tropical to cool temperate crops; from intensive animal husbandry in dairying, poultry and pigs, to the extensive farming of nondescript sheep and goats, and so forth" is such that the formulation of a common policy is "rendered difficult and at times impossible". Nevertheless the author is of the opinion that, apart from fruit, the South African livestock industry offers distinct advantages over the production of crops for sale. He thus advocates the need for a more vigorous policy in the conduct of pasture research and of measures for the further development of the animal industry.

The book, although perhaps a little pessimistic, affords a useful review of the agricultural situation in South Africa and should be read by all those who are interested in the future of agriculture in the Union.

G. G.

* * *

OXFORD FORESTRY MEMOIRS, No. 13, 1931.

Regional Survey and its Relation to Stocktaking of the Agricultural and Forest Resources of the British Empire. By Ray Bourne, M.A. *Oxford Clarendon Press*. pp. 169, illustrated.

In his Preface, the author stresses the fact that the possibilities of Regional Survey in relation to the scientific assessment of the Empire's resources is a matter of importance not only to scientists but to all concerned with the development of the Empire.

In the Introduction, it is urged that "the determination of the correct method of stocktaking forms the problems of primary importance within the Empire"; that questions of land policy and internal forest policy, and the periodical stocktaking required for the preparation and revision of Forest Working Plans all demand a thorough knowledge and understanding of local conditions, and that the need for investigating new methods of assessing local conditions must be recognised as of first importance.

Chapter I deals with the problems of locality assessment, it is pointed out that in the study of local conditions the extensive adoption of the method by which repeated observations and experiments are carried out over varying periods of time would involve centuries of research and an army of workers. The alternative method is proposed of a comparison of results under a variety of conditions, aiming at an elucidation of the past history of localities and an understanding of the changes which have been taking place in local conditions. It is urged that nothing but detailed investigation can prove satisfactory, with the consequent necessity for adopting the principle of sampling—usually strip sampling. In the survey of these strips the recognition of sites as units of locality is proposed, a site being defined as an area which appears "to provide throughout its extent similar local conditions as to climate, physiography, geology, soil and edaphic factors in general." Finally it is stated that by approaching the problem from the regional standpoint and adopting air survey the problem can be greatly simplified.

Chapter II gives a general description of some of the research undertaken and of the methods employed in England and summarises the results.

In Chapter III the author pleads for a scientific survey of the Empire for the solution of the problems both of Land Settlement and of the scientific development of Agriculture and Forestry.

An Appendix gives a detailed description of the area described generally in Chapter II and is illustrated by twelve excellent air photographic plates taken by the Aircraft Operating Co., Ltd.

The progress of the development of the ecological outlook in both Agriculturists and Foresters has been lamentably slow; as Mr. Bourne writes "Ecological survey has not received the encouragement it deserves . . . Agriculturists and certainly Foresters . . . have taken little interest in the matter." Many of the practical problems with which the forester is faced approach much nearer their solution when viewed for the first time from this angle.

This carefully written Memoir should prove a strong stimulus to increased interest in this neglected science.

R. L. B.

* * *

The English Plough.

By J. B. Passmore, M.Sc., Reading University Studies. *Oxford University Press.* pp. 84. Illustrated. Price 7*s.* 6*d.*

The College motto *Via colendi haud facilis* reminds us of the enormous amount of energy which is expended in tilling the soil, and since of the various operations, that of ploughing is undeniably the most important and most exacting, any book which deals with this operation or the efficiency of the implement with which it is performed, is to be welcomed. Mr. Passmore's work is a careful study of the English plough, from the historical as well as the constructional aspect. The importance of the latter can scarcely be over-emphasised, and the complexity of the problem and the many stages of development through which the modern plough has passed may come as a surprise to those unacquainted with the subject. The historical portion of the subject will perhaps be found most interesting by those who have already had some experience of the Tropics, for they will be strongly reminded by some of the illustrations—those, for instance, opposite page 2—of the simpler forms of plough in use today in many parts of the Tropics.

It is probable that most of the ploughing that is done in the Tropics today is done with a one-way plough of the general pattern of the Kent plough, to which, and to one-way ploughs in general, a special section is devoted. The balance or turn-over type has a special application in the Tropics either where irrigation is practised, for a field ploughed 'one-way' will not lose its levels, or where, as often happens, the business of feering out a field into even 'lands' is rather beyond the scope of the peasant ploughman. In experimental work, which implies the laying out of field plots, some kind of balance plough is a great convenience.

We congratulate Mr. Passmore and the University of Reading on this admirable treatise and commend it not only to students but to all those whose work brings them into contact with primitive forms of tillage implements.

R. C. W.

* * *

Social and Economic Geography.

By L. Brettle, M.A. (Oxon), B.Litt., F.R.G.S. *Sir Isaac Pitman & Sons, Ltd.*, London. pp. 459.

This book seeks primarily to describe natural environment and its relationship to human enterprise in different characteristic parts of the world. The subject matter is presented in two main portions. The first of these discusses the relief characteristics, climate, vegetation and animal life of the major regions of the world and the exploitation by man of their natural advantages. The second part of the book deals with world trade, commerce, transport and communications in these same regions. The author, to illustrate his text, has collected a large number of remarkable maps and photographs. The maps, we are told, have been drawn specially to summarize facts and features which are not usually available in a convenient form. Thus we find maps, amongst others of similar interest, illustrating the principal occupations of the human race, production and industries in different countries, the economic development of the Far East, the employment of British tonnage and the movement of Canada's wheat crop. The book gives a very stimulating picture of the utilization and disposal by man of the agricultural and mineral resources of the world and is to be recommended to those who desire to gain some understanding of this fascinating subject.

G. G.

MANURIAL EXPERIMENTS WITH SUGAR-CANE.

IV.*—A Comparison of the Effect of a Complete Inorganic Manure, and Single, Double and Triple Doses of Pen Manure, on the Yield of Plant and First Ratoon Uba Canes.

P. E. TURNER,
(*Soil Chemist to the Sugar-Cane Investigation Committee*),

and (in part)

J. A. POTTER,
(*Ste. Madeleine Sugar Co., Ltd.*).

[" *Livestock. In this item would appear to be the greatest possibility for economy, and we make recommendations for each Colony. The reason for the high expense under this heading is given in many parts as the necessity for obtaining large supplies of pen manure which, in the British West Indies, is considered essential for cane cultivation. The cost of pen manuring is very high, if to the cost of livestock is added the labour required for cutting grass, and "heading" out the manure; and we advocate the testing out of large areas without the use of pen manure, as is now done in Hawaii, Porto Rico, and parts of Jamaica. It cannot be denied that pen manuring is an excellent agricultural practice, but whether the return obtained pays for the labour expended and the upkeep of stock, when sugar is selling at low prices, is very doubtful on the basis of the cost of pen manure submitted to us.*" (*Section B, paragraph* 124 *of the Report of the West Indian Sugar Commission of* 1929.)]

I. Introduction.

On the sugar estates of Trinidad the manurial treatment of plant canes has been based primarily on the use of pen manure. In certain cases sulphate of ammonia also has been applied, but this manure has been considered of secondary value in comparison with pen manure. For example, when the financial position of the sugar industry in 1926 rendered economies in estate practice essential, the use of sulphate of ammonia was abandoned over large areas for some years.

Until very recently it has been the aim of the planter to apply to the acre of plant canes a dressing of pen manure of not less than 20 tons. On certain estates applications of 30 tons have been customary. The head of stock normally maintained on a sugar estate, for transport and general purposes, is inadequate to supply the quantity of pen manure which dressings on so liberal a scale require. In consequence there has been a well-defined policy on the part of most estates to augment the supply of pen manure by increasing the head of stock over and above that required solely for working purposes. The maintenance of stock essentially for the production of pen manure is an expensive procedure. The advisability of such a step can be tested only when full costings data are available.

An examination of the manurial situation in Trinidad, early in 1928, showed that information was not available in sufficient detail, with regard to the effect of quantity of pen manure on yield of sugar-cane under local conditions, to compare the cost of production of the manure with the gain in yield which accrues from its use.* Steps therefore were taken, on an estate interested in the problem, to obtain the missing data by means of a suitably designed experiment in the field.

One of the immediate aims of this experiment was to determine the effect of increasing doses of pen manure on yield of sugar-cane. The quantities to the acre of manure chosen for comparison were :—

(*a*) None,
(*b*) A unit dressing of 10 tons,
(*c*) A double dressing of 20 tons,
(*d*) A triple dressing of 30 tons.

Ten tons was selected as the unit treatment because a dressing at about this rate can be prepared without difficulty, by the use of working cattle alone, in amount adequate to supply the area under plant canes on most sugar-estates in Trinidad. If such a dressing were adopted as standard, no general need would arise for the maintenance of additional cattle. The double dressing of 20 tons corresponds to the application in general use in 1928, and still in vogue over large areas. The triple dressing of 30 tons corresponds to the maximum application in practical use.

It was further realised in 1928 that additional information was needed both with regard to the effect of a complete inorganic manure on the yield of plant canes and as to the value of such a manure in comparison with pen manure.† The scope of the experiment was therefore extended to include a fifth treatment, comprising a mixture of inorganic nitrogen, potash and phosphate. It is worthy of note that this trial was initiated previous to the appointment of the West Indian Sugar Commission of 1929.

It is recognised that pen manure has a definite residual effect, and that its influence on yield extends to the first ratoon crop and possibly also to the second ratoon crop. The plant and first ratoon canes on the experimental area have already been reaped. Upon the information thus obtained this paper is based. The second ratoons are to be reaped in 1932. The data to which they give rise will be discussed in a later publication.

The costings figures for the various treatments are quoted in Section V of this paper.

* The previous papers in this series are to be read at the Fourth International Conference of Sugar-Cane Technologists, to be held in Porto Rico in March, 1932.

* For an account of the information then available, *see* reference (6).

† For an account of the information available *see* references (4), (5), (6), (11), (12).

Details of the Experiment.

Soil Type.

A heavy, red-weathering clay, acid in reaction, deficient in humus, and badly in need of flocculation (7).

Cane Variety. Uba.

Previous History of Experimental Area.

There is no evidence in the estate records to indicate that the experimental area had previously received treatment with lime or pen manure. An artificial manure, in the form of 1½ cwt. of sulphate of ammonia, had been applied as a surface dressing in 1927.

Tillage Treatment of the Experimental Area.

The area was tractor-ploughed in the dry season of 1928.

Design of Layout.

The experiment was laid out in the form of two 5×5 Latin Squares (*see* Table II). There were 10 replicates of each manurial treatment.

The individual plots were 1/30 acre in area, *i.e.*, 22 feet (the bed width) by 66 feet.

Analyses of Manures.

Analyses of the manures used are recorded in Table I.

Table I.

Analyses of Manures.

Constituent.	Pen Manure per cent.	Sulphate of Ammonia per cent.	Rock Phosphate per cent.	Sulphate of Potash per cent.
N (total)	0.44	21	—	—
P_2O_5 (total)	0.20	—	33	—
K_2O (total)	0.63	—	—	49

The pen manure was prepared from cane trash according to the method adopted in Mauritius (2). The sample applied to the experimental plots was not specially selected, but was typical of that in general use.

II. Effect of Treatment on Yield of Plant Canes.

Date of Planting. November, 1928.

Manurial Treatments to the acre.

(1) No treatment.

(2) Complete inorganic manure.

(*a*) 90 lb. of Nitrogen as Sulphate of Ammonia.

(*b*) 375 lb. of total P_2O_5 as Ground Rock Phosphate.

(*c*) 60 lb. of K_2O as Sulphate of Potash.

Table II.

Plan of Experiment with Yields of Plant Canes in cwt. per plot.

The treatment numbers are given in brackets.

Latin Square I.

(1) 13.75	(5) 23.00	(4) 17.75	(3) 16.00	(2) 20.75
(4) 22.00	(2) 21.00	(1) 15.00	(5) 22.00	(3) 21.50
(2) 24.50	(1) 16.25	(3) 20.00	(4) 19.50	(5) 23.50
(3) 18.50	(4) 19.00	(5) 23.25	(2) 22.75	(1) 17.50
(5) 23.75	(3) 18.50	(2) 23.00	(1) 20.00	(4) 18.50

Latin Square II.

(1) 17.50	(5) 20.75	(4) 21.50	(3) 20.25	(2) 22.00
(4) 22.25	(2) 22.25	(1) 17.00	(5) 18.50	(3) 19.50
(2) 22.50	(1) 14.75	(3) 19.50	(4) 22.00	(5) 27.00
(3) 22.50	(4) 26.75	(5) 18.50	(2) 23.50	(1) 15.50
(5) 24.75	(3) 19.75	(2) 24.00	(1) 17.75	(4) 19.75

Treatment Means.

(cwt. per plot).

Treatment ..	(1)	(2)	(3)	(4)	(5)
Mean Yield ..	16.50	22.625	19.60	20.50	22.50

(3) A unit dressing of 10 tons of Pen Manure.
(4) A double dressing of 20 tons of Pen Manure.
(5) A triple dressing of 30 tons of Pen Manure.

Date of Application of Manures.
Pen Manure .. .. January, 1929.
Rock Phosphate and Sulphate of Potash .. .. January, 1929.
Sulphate of Ammonia .. July, 1929.

Mode of Application of Manures.
The pen manure was applied when the first bank was broken. The phosphate and potash were added previous to the breaking of the second bank. The sulphate of ammonia was applied as a surface dressing.

Date of Reaping. May, 1930.
Age of Plant Canes on Reaping. 18 months.

Yield Data.

The individual plot yields for the plant canes are given in Table II. Weighings were made to the nearest quarter (28 lb.). The canes were burnt prior to reaping.

Analysis of Yield Data.

Use has been made of the analysis of variance (3) to allow for the variation due to squares, rows and columns. The analysis is set out in Table III.

Table III.

Analysis of Field Data (Plant Canes).

Analysis of Variance.

Due to		Degrees of Freedom.		Sum of Squares.		Mean Square.	$\frac{1}{2}\log_e$.
Squares		1		7.0313		7.0313	
Rows		8		29.3000		3.6625	
Columns		8		12.3500		1.5437	
Treatments		4		254.5750		63.6437	2.07665
Error	Interactions of Squares and Treatments	4	28	26.0000	147.7750	5.2777	0.83175
	Between parallel plots	24		121.7750			
Total		49		451.0313			

Standard Error of a single plot $= \sqrt{5.2777}$.
Standard Error (mean of 10 plots) $= \sqrt{0.52777} = 0.7260$ or 3.55 per cent. of the mean yield from all plots (20.425 cwt.).

Table IV.

General Statement of Results.

Mean Yields of Plant Canes in tons per acre.

Manurial Treatment per acre.	Mean Yield.	Difference from			
		Tr. (1)	Tr. (2)	Tr. (3)	Tr. (4)
(1) No treatment	24.75	—	—	—	—
(2) Complete inorganic manure	33.94	**+9.19***	—	—	—
(3) 10 tons pen manure	29.40	**+4.65***	**−4.54***	—	—
(4) 20 tons pen manure	31.35	**+6.60***	−2.59	+1.95	—
(5) 30 tons pen manure	33.75	**+9.00***	−0.19	**+4.35***	+2.45

Results of Analysis.
From the analysis it is possible to assess the effect of treatment on the yield of plant canes.
For P=0.01, when $n_1=4$ and $n_2=28$, $z=0.7023$. The difference due to treatment in Table III is 2.07665−0.83175, or 1.2449. The effect of treatment might therefore be due to chance far less than once in 100 times, and is undoubtedly significant.

The standard error of the difference between any two of the mean yields per acre recorded in Table IV is equal to $\frac{30}{20} \times \sqrt{\frac{5.2777 \times 2}{10}}$ tons or 1.5411 tons. For P=0.05, t=2.048 when n=28. A difference, to be statistically significant (*i.e.*, due to chance less than once in 20 times) must therefore exceed 2.048 × 1.5411, or 3.156 tons. Such differences are marked in the table with an asterisk.

For P=0.01, t=2.763 when n=28. A difference which might be due to chance less than once in 100 times must therefore exceed 2.763×1.5411, or 4.258 tons. Such differences are denoted by heavy type in Table IV.

Conclusions for Plant Canes.

The following conclusions may be drawn from the data in Table III for the Uba *plant canes* growing on a red-weathering clay soil.

(1) *General.*

(*a*) The pen manure treatments (irrespective of magnitude) and the complete inorganic manure, give increments in yield which might be due to chance less than once in 100 times.

(*b*) The increment in yield of 6.6 tons of cane to the acre, due to 20 tons of pen manure, is in agreement with the increments obtained by this treatment in other experiments on the same soil type (9).

(2) *Single v. Double v. Triple Dressings of Pen Manure.*

(*a*) The yield from the double dressing is not significantly different from that given by the unit dressing.

(*b*) The yield from the triple dressing is not significantly different from that given by the double dressing.

(*c*) The yield from the triple dressing is significantly greater than that given by the unit dressing.

(3) *Inorganic v. Pen Manure.*

The yield obtained by treatment with the inorganic manure is :—

(*a*) Significantly greater than that given by the unit dressing of 10 tons of pen manure.

(*b*) Equal to that given by the triple dressing of 30 tons of pen manure.

III. Residual Effect on Yield of First Ratoons.

Manurial and Tillage Treatments.

The first ratoon canes received no manurial or tillage treatments. Any effect of the treatments given to the plant canes on the yield of first ratoons may therefore be considered "residual" in nature.

Age of Ratoon Canes on Reaping.—11¾ months.

Table V.

Yield Data.

Yields of First Ratoon Canes in cwt. per plot.

Square I.

(1) 10.25	(5) 14.00	(4) 15.00	(3) 13.00	(2) 12.25
(4) 14.00	(2) 15.25	(1) 11.25	(5) 16.00	(3) 15.00
(2) 13.00	(1) 11.00	(3) 12.75	(4) 14.00	(5) 15.75
(3) 11.00	(4) 12.50	(5) 15.25	(2) 16.50	(1) 11.00
(5) 12.75	(3) 13.50	(2) 14.50	(1) 11.25	(4) 15.00

Square II.

(1) 9.50	(5) 12.75	(4) 13.75	(3) 12.25	(2) 15.75
(4) 11.75	(2) 12.75	(1) 10.25	(5) 14.00	(3) 12.00
(2) 12.50	(1) 8.75	(3) 11.75	(4) 16.25	(5) 18.00
(3) 11.50	(4) 14.25	(5) 14.00	(2) 16.00	(1) 11.25
(5) 10.75	(3) 9.25	(2) 12.00	(1) 9.75	(4) 11.50

Treatment Means.

(cwt. per plot)

Treatment ..	(1)	(2)	(3)	(4)	(5)
Mean Yield ..	10.425	14.05	12.20	13.80	14.325

Table VI.

Analysis of Yield Data.

Analysis of Variance.

Due to		Degrees of Freedom.	Sum of Squares.	Mean Square.	$\frac{1}{2}\log_e$.
Squares		1	11.0450	11.0450	
Rows		8	32.1750	4.0219	
Columns		8	38.4000	4.8000	
Treatments		4	107.6075	26.9019	1.6462
Error	Interactions of Squares and Treatments	4 } 28	2.2675 } 31.1925	1.1140	0.0539
	Between parallel plots	24	28.9250		
Total		49	220.4200		

Standard Error of a single plot $= \sqrt{1.1140}$

Standard Error (mean of 10 plots) $= \sqrt{0.1114} = 0.3338$, or 2.575 per cent. of the mean yield from all plots (12.96 cwt.).

Results of Analysis.

The residual effect of treatment upon the yield of first ratoon canes can be assessed from the data in Table VI.

As in the case of the data for plant canes, $z = 0.7023$ for $P = 0.01$. The effect due to treatment in Table VI is $1.6462 - 0.0539$ or 1.5923. The residual effect might therefore be due to chance less than once in 100 times.

The standard error of the difference between any two of the mean yields per acre recorded in Table VII, as determined by the use of the analysis of variance, is equal to $\frac{30}{20} \times \sqrt{\frac{1.1140 \times 2}{10}}$ tons or 0.708 tons. A difference to be due to chance less than once in 20 times must exceed 2.048×0.708 or 1.450 tons. To be due to chance less than once in 100 times it must exceed 2.763×0.708 or 1.956 tons.

Conclusions for First Ratoon Canes.

The following conclusions may be drawn for the *"residual" effect of treatment on the first ratoon canes* :—

(1) *General.*

The residual effect on yield of the pen manure treatments, *and of the complete inorganic manure* is definitely significant and might be due to chance less than once in 100 times.

Table VII.

General Statement of Results.

Mean Yield of First Ratoon Canes in tons per acre.

Manurial Treatment per acre as Plant Canes.	Mean Yield.	Difference from			
		Tr. (1)	Tr. (2)	Tr. (3)	Tr. (4)
(1) No treatment	15.64	—	—	—	—
(2) Complete inorganic manure	21.075	+5.43*	—	—	—
(3) 10 tons pen manure†	18.30	+2.66*	−2.775*	—	—
(4) 20 tons pen manure†	20.70	+5.06*	−0.375	+2.40*	—
(5) 30 tons pen manure†	21.49	+5.85*	+0.415	+3.19*	+0.79

† These are the first measurements which have been made in Trinidad of the residual effect of pen manure on the yield of ratoon canes.

(2) *Single v. double v. triple dressings of Pen Manure.*

(*a*) The yield on the plots which were given 20 or 30 tons of pen manure is significantly greater than that on the plots which received 10 tons of pen manure.

(*b*) The yield on the 30 ton plots is not significantly different from that on the 20 ton plots.

(3) *Inorganic v. Pen Manure.*

The yield of first ratoon canes on the plots which received the complete inorganic manure is :—

(*a*) Definitely significantly greater than that from the plots which were given 10 tons of pen manure.

(*b*) Approximately equal to that from the plots which received 30 tons of pen manure.

IV. Costings.

The costings data are based on the total yields for plant canes and first ratoons, which are recorded in Table VIII.

Table VIII.

Total Yields of Plant and First Ratoon Canes per acre.

Manurial Treatment per acre in 1929.	Yield tons per acre.	Difference from			
		Tr. (1)	Tr. (2)	Tr. (3)	Tr. (4)
(1) No manure	40.39	—	—	—	—
(2) Complete inorganic manure	55.01	**+14.62***	—	—	—
(3) 10 tons pen manure	47.70	**+ 7.31***	**- 7.31***	—	—
(4) 20 tons pen manure	52.05	**+11.66***	−2.96	**+4.35***	—
(5) 30 tons pen manure	55.24	**+14.85***	+0.23	**+7.54***	+3.19

Standard Error of Difference (mean of 10 plots) for Total Yields = 1.935 tons per acre.
Significant Difference (1 in 20) = 4.05 tons per acre.
(1 in 100) = 5.40 tons per acre.

The costings data are set out in Table IX. It should be noted that the data apply to one particular estate which is situated in undulating country. They are arranged, however, in a manner such that they may readily be adjusted to suit the requirements of the estates which lie in the Central Plain.

Table IX.

Costings Data for Plants and First Ratoons.

Manurial Treatment as Plants.	Increment in Yield (tons per acre).	(a) Value of Increment in Truck at Field.	Additional Costs.			Net Gain due to Manuring.
			(b) Manuring.	(c) Extra Reaping.	Total.	
		$	$	$	$	$
(1) None	—	—	—	—	—	—
(2) Complete inorganic manure	14.62	48.25	19.66	8.77	28.43	+19.82
(3) 10 tons pen manure	7.31	24.12	15.50	4.39	19.89	+ 4.23
(4) 20 tons pen manure	11.66	38.48	30.00	7.00	37.00	+ 1.48
(5) 30 tons pen manure	14.85	49.00	44.50	8.91	53.41	− 4.41

(*a*) *Value of Cane* in truck at field is taken as $3.30 per ton.

(*b*) *Cost of Manuring.*

(1) *Complete inorganic manure.*

4 cwt. S/A at $30.00 per ton ..	6.00
10 cwt. rock phosphate at $19.00 per ton	9.50
120 lb. S/P at $2.95 per cwt. ..	3.16
Cartage and application	1.00
Total	19.66

(2) *Pen Manure.*

Dose of Manure ..	10 tons	20 tons	30 tons
Value of manure ..	$ 10.00	$ 20.00	$30.00
Cartage	3.00	6.00	9.00
Application ..	2.50	4.00	5.50
Total ..	$ 15.50	30.00	44.50

(*c*) *Cost of Reaping* is taken as 60 cents per ton.

The costings data are in some ways biassed in favour of treatment with pen manure. For example, the composition of the inorganic manure is far from ideal. Its most expensive component is 10 cwt. of rock phosphate, which could be replaced by 1 cwt. of superphosphate, or at the most 2 cwt., not only with advantage but with considerable economy. Further, at the time of writing, the price of sulphate of ammonia is $24.00 per ton, or $6.00 less than the figure used in the calculation.

Again, there can be little doubt that the nitrogen of the inorganic manure has not been used in the experiment to the maximum advantage. The canes were planted in November, 1928, and

the sulphate of ammonia applied in July, 1929. It would have been preferable to add one half of the dressing shortly after planting, rather than to deprive the cane of the benefit of this fertiliser during the critical first eight months of its growth. It is also highly probable that additional gain would accrue by giving 2 cwt. of sulphate of ammonia to the ratoons.

The cartage costs of the inorganic manure are placed at a rather high figure, which could be lessened very appreciably by the use of a complete fertiliser.

The pen manure is given a nominal value of $1.00 per ton. This valuation is purely conventional. Under the most favourable conditions it is unlikely that the manure can be produced at present on any sugar estate for less than $1.20 per ton.

V. Discussion.

The Optimum Dose of Pen Manure.

The Form of the Yield Curve.

In Figure I yield of sugar-cane to the acre is plotted against dose of pen manure. As each additional increment of manure results in a progressively smaller increment in the total yield of plant and first ratoon canes, this curve obeys the Law of Diminishing Returns. *Theoretically, therefore, maximum gain is obtained from the pen manure available by spreading the supply as evenly as possible over the whole area under plant canes. Unless disturbing factors* intervene, it is economically unsound to apply very large dressings over one portion of the area and correspondingly smaller dressings over the remainder.*

The Optimum Economic Dose of Pen Manure.

It will be seen from Table VIII that, for the total yield of plant and ratoon canes, 10 tons of pen manure result in a net gain of $4.23 to the acre, and that 20 tons give a smaller gain of $1.48. The dressing of 30 tons leads to a net loss of $4.41 to the acre.

In Figure II the total net gain or loss to the acre is plotted against the dose of pen manure. The curve obtained is parabolic in form. It demonstrates that, *under the conditions of the experiment, the net gain to the acre increases rapidly as the dose of pen manure increases, until the dose attains a value of 10 to 12 tons. Beyond this range the gain falls rapidly, reaching zero when the application lies in the region of 23 tons. If the dose is made still larger a net loss is incurred which increases almost proportionately as the dressing increases.*

It will be recollected that a supply of pen manure, sufficient for a dressing of 10 tons to the acre over the area under plants, can be produced on most sugar estates by the head of cattle kept for working purposes alone. The maintenance of additional stock essentially for the preparation of manure therefore does not appear to be a paying proposition.

* Such as the inaccessibility of a section of the estate.

Inorganic Manure versus Pen Manure.

The Use of Inorganic Manures.

The net gain to the acre is $19.82 for the complete inorganic manure (Table IX). According to Figure II, the maximum net gain to the acre for pen manure is $4.35. Ten tons of pen manure result in a gain of $4.23 (Table IX). *Under the conditions of the experiment, therefore, sugar-cane can be grown far more cheaply, and without reduction in yield, by the use of a complete inorganic manure in place of pen manure.*

In view of the low price of sugar and the present precarious position of the industry, this conclusion is of vital importance. To confirm it, and to test whether it is generally valid, experiments are being laid down on some of the major soil types of the island (8). The information which these experiments are designed to give rise should be available in the course of a few years.

Certain modifications in general estate practice, however, can immediately be introduced or extended with safety. Fairly large areas exist in the sugar belt of Trinidad for which no pen manure is available, or to which pen manure cannot be transported because of their inaccessibility under wet season conditions. *Applications of a complete fertiliser to the plant canes on these areas should be a sound commercial proposition.* Again, on areas to which pen manure is applied to plant canes, as a routine procedure, in amounts of the order of 10 tons to the acre, *there can be little doubt that it would be financially advantageous to supplement the dressing with artificials* (10). Experiments are in progress on several estates in Trinidad to determine the optimum mixture and dose of artificials in the presence of pen manure (8).

Objections to Inorganic Manures.

From time to time objections have been raised in Trinidad to the use of inorganic manures in preference to pen manure. The arguments in favour of pen manure have been based on the following grounds :—

(1) Pen manure is not as costly as it appears at first sight, in that its beneficial effect on yield extends to the subsequent ratoon canes as well as to the plants. Inorganic manures have been credited with no such effect.

(2) Pen manure increases the moisture holding capacity of the soil.

In dry wet-seasons, on light soils, the result of replacing pen manure by an inorganic manure might be fatal.

(3) It is doubtful whether inorganic manures alone would give satisfactory results on the heavy, acidic, humus deficient, unflocculated clays of Trinidad. In countries where artificials are extensively used for the manuring of sugar-cane the soils are open in character and in good tilth.

(4) Pen manure improves, or at least maintains, the tilth of the soil, whereas long continued use of inorganic manures would in time destroy any measure of tilth which the soil may possess.

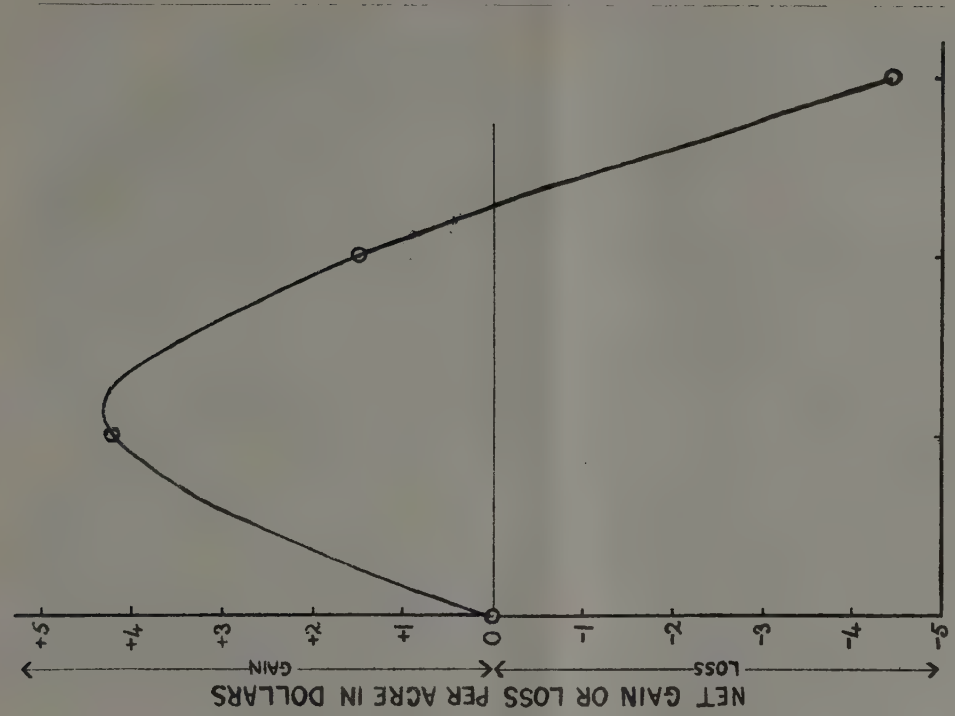


Fig. II.—Relationship between dose of Pen Manure and Net Gain or Loss per acre. (Plotted from the actual Costings Data for Plants and First Ratoon Canes recorded in Table IX.)

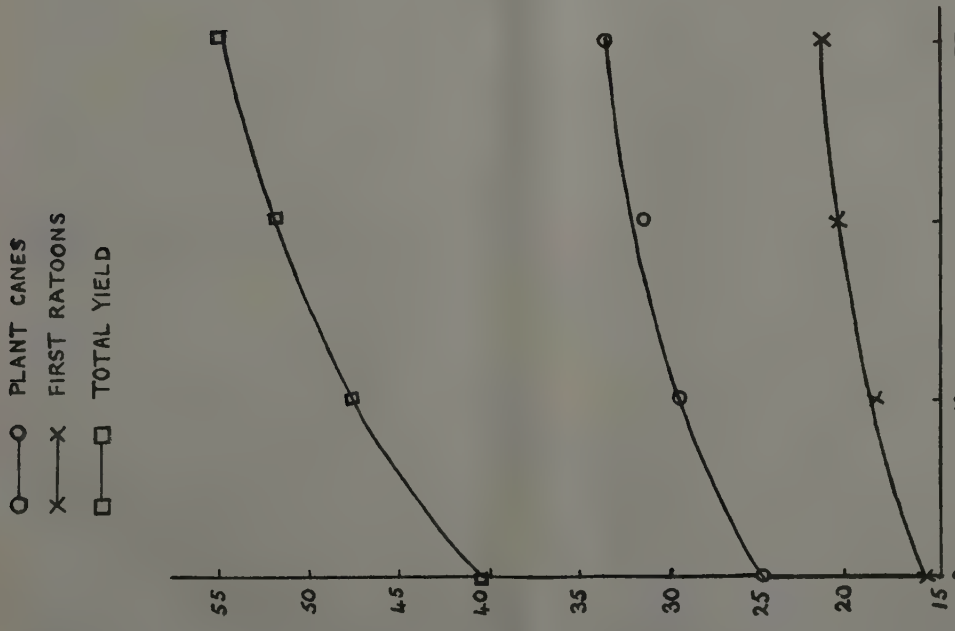


Fig. I.—Effect of increasing doses of Pen Manure on yield of Plant and First Ratoon Canes.

Some of these arguments can be dealt with directly by means of the data in Tables IV, VII and IX. No local information as yet is available concerning others, but they may to some extent be answered by a study of the manurial practices in vogue in other sugar producing countries. The various points raised are discussed in order below.

(1) According to the data in Table VII the complete inorganic manure exerts a residual effect on the yield of first ratoon canes equal to that due to 30 tons of pen manure.

(2) Any modification in the moisture holding capacity of the soil, which may have resulted from a dressing of 30 tons of pen manure, did not increase the yield of either plant or first ratoon canes, in the experiment described, beyond that given by the inorganic manure.

The argument in favour of applying pen manure to light soils, because of the risk of a dry wet-season, at present is an open one. It can satisfactorily be decided only by field experiments. The experience of other sugar producing countries, with climatic conditions comparable to those of Trinidad, is favourable to the use of artificials on light soils.

(3) The experiment described was laid down on clay soils which are notoriously heavy in character, acid in reaction, deficient in humus and poor in tilth. In spite of the unfavourable properties of these soils the inorganic manure gave excellent results. Equally good results have been obtained by the use of artificial fertilisers on ratoon canes growing on soils of similar character.

(4) It is very doubtful whether applications of pen manure, of the order of 20 tons, appreciably ameliorate the physical condition of the heavy, unsaturated clays of the sugar belt of Trinidad. The quality of the manure as a humus producing material appears poor. The quantity appears quite inadequate to mask those undesirable characteristics of the soil which are due to the presence of an overwhelming preponderance of the clay fraction. A long interval appears to elapse before appreciable decomposition of the manure occurs. The length of time which humus, when formed, persists in the soil appears short.

Continued heavy dressings of sulphate of ammonia will undoubtedly tend slowly to increase the acidity of the soil, but its effect may be neutralised by occasional small applications of lime.*

The Relationship of the Experimental Data to the Froghopper Problem.

The experimental data possess an important bearing on the froghopper problem in Trinidad. Both in years of light and severe infestations of this pest, ratoon canes are known to suffer far more severely than plant canes. The cost of establishing a field of plant canes, including pen manuring, lies in the region of $80.00 or $90.00. The cost of maintaining a field of ratoon canes falls around $12.00 to $16.00. The relative inexpensiveness of ratoon canes, in comparison with plants, has previously made impossible serious consideration of a reduction in the number of ratoon crops to minimise the area liable to severe blight. Partial or complete replacement of pen manure by artificials, however, if combined with certain other modifications in estate practice, might lower the cost per ton of plant canes to a level at which it becomes financially feasible to replant when the first ratoons have been reaped. On the other hand, as it has been thoroughly demonstrated that large increments in yield of ratoon canes can be very cheaply obtained by appropriate use of artificials,* it may be considered more worth while to maintain or even increase the number of ratoon crops, and to take the risk of possible damage through blighting once in every few years.

VI. Summary.

(1) The policy, in vogue in Trinidad in 1928, with regard to the manurial treatment of plant canes is briefly reviewed. It is pointed out that the lack, at that time, of detailed information, concerning the effect on yield of plant canes, and of the subsequent ratoons, of the size of dose of pen manure, and of a complete inorganic manure, made it impossible to gauge the merits of the practice in common use.

(2) Details are given of an experiment laid down in the field in 1928 to provide the missing information. In it the effect on yield of plants and first ratoon canes of the following manurial treatments were compared: (*i*) No treatment, (*ii*) Complete inorganic manure, (*iii*) 10 tons pen manure, (*iv*) 20 tons pen manure, and (*v*) 30 tons pen manure.

Costings data are recorded for the various treatments.

(3) *Pen Manure.*

(*a*) The yield data for the pen manure treatments show that each additional increment in dose results in a progressively smaller increment in total yield of plant and ratoon canes. Theoretically, therefore, maximum gain is obtained from the pen manure available by dividing the supply as evenly as possible over the whole area under plant canes.

(*b*) The costings data for the pen manure treatments demonstrate that, under the conditions which obtained, the net gain to the acre increases rapidly as the dose of manure increases, until the dressing attains a value of from 10 to 12 tons. Beyond this range the gain diminishes rapidly. With applications larger than 23 tons a net loss is incurred. As a supply of pen manure adequate to provide a dressing of about 10 tons to the acre can be produced without difficulty by the head of cattle kept on estates solely for working purposes, it is not a paying proposition to maintain additional stock essentially for the preparation of larger quantities of this manure.

* The maximum acidity to which 1 cwt. of sulphate of ammonia can give rise can be neutralised by 1½ cwt. of finely ground limestone.

* An account of the experiments which have established this statement will be published later.

(4) *Inorganic Manure.*

(*a*) The complete inorganic manure gave an increment in yield of plant and first ratoon canes of 14.6 tons. This is equal to the increment given by a dressing of 30 tons of pen manure.

(*b*) The net gain to the acre by the use of the inorganic manure was $19.82. The maximum net gain to which pen manure could give rise was $4.35. Under the conditions of the experiment sugar-cane can be grown certainly without reduction in yield, and with much greater profit, by replacement of inorganic manure for pen manure.

(*c*) Suggestions are made as to the manner in which inorganic manures can immediately, and with safety, in Trinidad be put into use for the treatment of plant canes.

(*d*) Certain objections which have been raised to the use of inorganic manure are discussed.

(5) Mention is made of the relationship which the information obtained bears to the froghopper problem in Trinidad.

Acknowledgments.

The authors are indebted to the General Manager of the Ste. Madeleine Sugar Co., Ltd. for permission to publish the yield and costings data, and to Mr. G. A. Jones, who laid down the experiment, for his very active interest in the results.

VII. Appendix.

Manurial Practice in Porto Rico and Hawaii.

Porto Rico.

With one or two exceptions pen manure is not used on sugar estates in Porto Rico. The working stock is grazed in pasture and the manure lost. It is maintained that the cost of preparing the manure in the pen and applying it to the field is prohibitive. In general, inorganic manures alone are used, and are found to give satisfactory results even on unirrigated areas. The following figures, taken for one year at random, illustrate this point.

Estate A (Unirrigated), Crop 1926.

400 lb. of a mixture containing 12 per cent. N, 6 per cent. P_2O_5, and 5 per cent. K_2O were applied to the plant canes at the first weeding, and 200 lb. of sulphate of ammonia six weeks later.

Wet season plants ..	41.8 tons to the acre.		
Crop plants ..	36.1	do.	do.
First ratoons ..	26.7	do.	do.
Second ratoons ..	21.1	do.	do.
Third ratoons ..	20.0	do.	do.
Other ratoons ..	21.04	do.	do.

Average yield for 8,400 acres = 27.8 tons to the acre.

The soils of this estate are considered to be heavy in character, but they are relatively open and light in texture in comparison with the clay soils of Trinidad.

Hawaii.

No attempt is made in Hawaii to incorporate organic matter with the soil. Fallowing, rotation of crops, green manuring, and the ploughing under of trash or crop residues are rarely or never practised.

Ten years ago 50 or 60 lb. each of P_2O_5 and K_2O (equivalent approximately to 250-300 lb. of superphosphate and 100-120 lb. of sulphate of potash, respectively) were common applications of phosphate and potash to the acre. Now dressings of 150 or 200 lb. (and sometimes 300 lb.) are customary. On many estates the increased doses are based on the results of field experiments. On others the larger doses are precautionary in character, *i.e.*, they ensure that maximum use is made of the nitrogen applied and they build up a reserve of plant food in the soil.

It is believed by Dr. Agee, the Director of the Experiment Station Staff of the Hawaiian Sugar Planters' Association, that *a system of permanent agriculture, based on intensive use of inorganic manures, has been established in Hawaii* (1). In support of his contention he quotes yield figures for the sugar estates of the islands. In 1922, an average yield of 4.79 tons of sugar was obtained. In 1929 the average yield was 6.88 tons. There appear to be no signs of a diminution in yield in the future. Irrigation and length of the growing season play an important part in the production of such high tonnages, but this does not effect the main issue, that heavy crops can successfully be raised, over a long period of years, without recourse to organic manures.

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WEST INDIAN TOMATOES.

Refrigerated Transport of Tomatoes.

(Précis of a Report submitted to the Empire Marketing Board).

By Claude W. Wardlaw and Laurence P. McGuire,

Low Temperature Station, Imperial College of Tropical Agriculture.

[*This investigation into the behaviour and diseases of tropically-grown tomatoes in storage was undertaken at the request of the Commissioner of Agriculture for the West Indies in order to provide information for the several Islands interested in the export of this commodity to Canadian Markets. It should be placed on record that it has only been possible to carry out the necessary experiments through the courtesy of the Executive Officers of the Empire Marketing Board, who, appreciating the necessity for such work in view of the proposed Canada-West Indies Development, readily consented to our undertaking research on tropical commodities other than the banana, for which the Station was primarily erected.*]

On account of the fortnightly distribution of shipping facilities available between the Islands and Canada, it may be necessary to retain picked fruit in local pre-cooling stations for periods ranging up to 10 days. Thereafter the fruit will be kept in cold storage for another period of approximately 10 days during ocean transport. On arrival at the Canadian port it should still be sufficiently immature to permit of distribution, marketing, &c., over a period of perhaps 14 days, without undue loss from over-ripeness and the concomitant fungal and bacterial wastage. In short, the problem involves a guaranteed storage life of approximately 30 to 34 days. In outlining a standardised experimental programme (2), to facilitate the co-ordination of results, it was indicated that each Island must work out its own particular requirements regarding variety of fruit, the precise stage of maturity at which to reap, and optimal storage temperatures, since, as indicated by the relevant literature (1) this commodity presents difficulties in storage.

At the Low Temperature Station, storage trials with uniform consignments of different varieties have been carried out at temperatures ranging from 40° to 53°F., at a relative humidity of approximately 85 to 95 per cent., for periods of 10, 15 and 20 days, with subsequent ripening at 70°F. and a relative humidity of 80 to 85 per cent., accurate records of ripening and wastage being made throughout. The precise stage of maturity at which to reap was determined by comparing consignments of fruit full-grown but green with others where different degrees of colouration had appeared. The effects of (1) delayed refrigeration, (2) abnormal pre-storage cultural conditions, (3) variety and (4) reaping with and without stem-buttons, have also been recorded from the appropriate experiments. Attention has also been devoted to the effect of exposure to tropical temperatures during transference from harbour pre-cooling stations to the ships' holds and allied problems. In the purely mycological work, isolations of fungi and bacteria, measurements of growth rates, &c., were conducted on standard lines.

The following conclusions and recommendations are submitted:—

1. Reference to relevant literature, which deals with the tomato grown in regions outside the tropics, reveals the rather marked opinion that with this commodity it is not possible to delay for any considerable period the onset of senescence and decline by refrigerative methods. Where a storage expectancy of one month or more has been claimed, the authors have stressed the alarmingly rapid wastage concomitant with removal from the low temperatures. The better grades of Trinidad-grown tomatoes have been repeatedly held in cold storage for periods of as long as 20 days, followed by a distribution period of 10 to 14 days without undue wastage—a condition of affairs eminently suited to the requirements of a West Indies-Canada trade.

2. From a consideration of temperature in relation to (1) the incidence of fungal and bacterial diseases, (2) the retardation of the ordinary life cycle and (3) the development of suitable colouring on removal from cold storage, it appears that optimal temperatures for the varieties used lie in the vicinity of 47.5°F., with subsequent ripening at higher temperatures according to (*a*) the demand for ripe fruit and (*b*) its final destination.

In adapting this finding to actual practice, it should be remembered, in view of the wide range of cultural and climatic conditions obtaining in the West Indies and their possible influence on longevity of fruit in storage, that our observations, based entirely on Trinidad-grown commercial fruit, may require slight modification in specific cases.

3. The question of maturity at picking—an exceedingly important one—has received considerable attention. For the longer periods of ocean transport followed by a possible extended distribution and marketing period, fruit should be reaped at a stage best described as full-grown but green. On the other hand, under circumstances of rapid delivery and distribution, the acceptance of fruit commencing to show colour at the time of reaping is not precluded, and in particular instances may prove advantageous. This is essentially a matter for local experience.

4. In suggesting the possibility of using for export, fruit reaped at different stages of maturity, the greatest care should be exercised in establishing uniformity within the packs, suitable and distinctive labelling being adopted.

5. The evils attendant on delay between the time of reaping and commencement of refrigeration have been clearly demonstrated and the reduction of this time to the minimum is strongly advocated. Fruit not only depreciates as a result of early wilting and over-ripeness but the pathogens make rapid inroads during the exposure to the higher temperatures.

6. Fruit suspected of abnormalities as a result of unusual cultural conditions should not be accepted for transport overseas.

7. The merits of not removing the stem-buttons when reaping has been shown in the case of certain varieties: while the persistence of the withering calyx has been condemned by the Trade on the grounds of unsightliness, varieties may be found in which a caducous calyx is the rule. The incidence of button infections was found to be directly correlated with both the time and temperature factors, being chiefly in evidence towards the end of long storage trials.

8. The important question of the influence of exposure to tropical temperatures on packs in transference from the several pre-cooling stations to the ship's holds has been considered in some detail. The exposure *per se* of 4 hours resulted in no appreciable modification of the usual storage behaviour, but the smallness of our consignments must be taken into account. Packages thus exposed were found to have collected a considerable amount of condensation water, mainly on the marginal layers of the cargo stack. On return to our cold chambers, which are refrigerated by the so-called Cold Air Blast system, the packages dried quickly; the individual wrappers were quite unsoiled and showed no tendency to adhere to the fruit—in short the appearance of the packages was not adversely affected by the exposure to the tropical temperatures. With large consignments, especially as it is not expected that separate cold chambers will be available for the consignments of each of the several Islands, it will most probably be found necessary to insulate as far as possible the stacks of crates in transit to the ship. A comparatively inexpensive, readily-portable and efficacious contrivance is referred to in the text.

9. Wastage other than over-ripeness and wilting in experimental consignments could be attributed to

(i) Fungi and bacteria.
(ii) Cracks and bruises.

The common moulds, mainly responsible for the rotting of ripe tomatoes in temperate countries, have been almost entirely absent from our storage trials. Some account is given of the different types of infection encountered and of the micro-organisms involved.

All fruit showing the slightest trace of infection or mechanical injury should be rejected by the packers. Many fungi and bacteria, though present as minute latent infections at the time of reaping, escape detection and are, therefore, on their subsequent development, to be regarded as normal wastage. A consideration of the growth rates of the more important pathogens on synthetic media at different temperatures showed that a satisfactory control could be achieved at 45° to 47.5°F.

50°F. appears to be a critical temperature for the several tomato pathogens isolated: above this temperature the rate of growth, and therefore wastage, increases rapidly.

10. If the storage behaviour of commercial fruit grown in the interested Islands proves comparable with that of the better grades of Trinidad tomatoes, it may be asserted confidently that the outlook is promising.

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NICOTINE.

The Extraction and Uses of Nicotine of Tobacco.

[*The following article is taken from a paper read by Mr. J. H. Reid before the Liverpool Section of the Society of Chemical Industry. The article is published in full in the November 20th, 1931, issue of the Society's Journal, to which acknowledgment is here made.*]

THE root and thick main stalk of the tobacco plant contain little nicotine; the thinner mid-rib of the leaf contains from 0.5 to 1.05 per cent. whereas the bulk of the nicotine is in the thin leaf, which contains up to 8 per cent., according to the variety. This shows how the alkaloid is produced by the action of sunlight. Darkness in the cured leaf does not always indicate high nicotine content. Some contend that the curing of the leaf decreases the nicotine content. The nicotine and its allies are combined with citric, malic, oxalic, and other organic acids; although important from the smoker's standpoint, the other constituents of tobacco leaf do not concern us at the moment.

Extraction of Nicotine.

Ordinary tobacco leaf is too costly to be utilised for the manufacture of nicotine, as the raw material after extraction by the usual processes would be unfit for smoking purposes. On the Continent, however, some leaf of rank quality is washed with water in order to make the tobacco or cigarettes produced from it more tolerable, and these liquors are collected from the numerous small tobacco factories and centralised for the extraction of nicotine. Processes for the removal of nicotine from the leaf have been patented, but little headway has been made in this direction owing to tobacco manufacturers being unwilling to risk the deterioration of their proprietary brands of tobacco and cigarettes, and no doubt they are wise in view of the delicate flavours which might be removed by such treatment. Recently, however, it has been reported that the Soviet intend treating "machorka", the tobacco to be used subsequently by the peasants for the production of nicotine on a very large scale.

Raw Material.

The usual raw material consists of:—(1) unsaleable leaf or scraps produced during harvesting and during drying and packing; (2) the mid-rib

of the leaf ; (3) the débris from tobacco factories, which in this country is described as shorts, smalls, and offal snuff. In this country the manufacture is supervised by the Customs and Excise Authorities, and the operations are conducted in bonded premises. The necessity for such will be clear from the following explanation of the origin of the raw material and how it reaches the nicotine manufacturers. Leaf tobacco is taken from the ship and stored for anything up to three years in a bonded warehouse, where it remains until required for conversion into cigarettes or pipe tobacco. The tobacco manufacturer pays duty on the quantity required to be removed to his factory, and converts as much as possible into the form desired by the smoking public. During this process the mid-rib is usually, but not always, removed ; some smokers like bird's eye in their shag, and others the longer mid-rib in their roll or stick. The débris from the sifting of shags and mixtures, and also from the cigarette machines, is rejected ; to this may be added "returns", *i.e.*, tobacco returned from retailers as having deteriorated. The manufacturer has not only paid the intrinsic value of this rejected material, when in the form of leaf, but also the duty. Duty, however, is only payable on tobacco used for human consumption, and is recoverable on the rejected material to some extent, as drawback by deposit with Customs, either at the King's warehouses or in a warehouse or factory approved by the authorities. As the price of nicotine produced from duty-paid refuse would be prohibitive, the manufacture of the alkaloid is carried out in an approved bonded factory so that drawback may be obtained. Tobacco refuse for drawback arrives in bags, usually containing 100 lb., which are weighed and sampled by Customs officials, drawback being paid on standards having reference to moisture, sand, and organic content. Before this material found an outlet for such main uses as nicotine manufacture or sheep dip powder it was either destroyed in furnaces, called the King's Pipe, or dumped at sea.

Uses of Nicotine Extracts.

The alkaloid was first used in this country in the form of *tobacco juice*—a simple aqueous extraction —and also in the form of tobacco paper—the wrappings of roll tobacco while being pressed. Tobacco juice—more largely used in sheep breeding countries—is prepared abroad on a large scale by making a bath of water and tobacco sheep dip powder ; a finely divided mixture of tobacco, sulphur, soda-ash, and carbolic acid. *Tobacco extract* (a concentrated aqueous extraction of tobacco refuse of the consistency of treacle and containing some 7 to 8 per cent. of nicotine), is also largely used abroad, but its use is prohibited in this country by the Customs and Excise Authorities. Tobacco paper was used for fumigating glasshouses by burning, but, as the nicotine content was so variable, it was supplanted by vapourising compounds in which the evaporation of nicotine by means of a spirit lamp was aided by the addition of methylated spirit and, in some cases, camphor. Vapourising compounds have had to give way, although not entirely, to what are called tobacco shreds—usually paper soaked in a solution of salpetre, dried and impregnated with a mixture of linseed oil and nicotine — which only require placing in a flower-pot and igniting.

Improved and cheaper methods of production have led to the commercial use of *nicotine sulphate* and a dark coloured *nicotine* of 95 to 98 per cent. purity, whilst in recent years a pale straw-coloured nicotine, almost of full purity, has been offered freely. The last-named is required for the compounding of vapourising liquids to be used for destroying insect pests on white blooms under glass. The use of nicotine sulphate and nicotine (95 per cent.) has greatly increased since commercial growers turned their attention to combating the attack of insect pests on outdoor crops. Nicotine sulphate and nicotine (95 per cent.) are diluted with water, and alkali being added in the case of the former to liberate the nicotine and using soft soap as a spreader. Insecticide manufacturers also compound spraying liquids to formulae which have been tried out in field experiments. The dilution, which may be one pt. to 1,000 pt. of water, is regulated to the pest to be destroyed. Again, the alkaloid and sulphate provide the essential principle of proprietary *nicotine dry sprays*, which are exceedingly finely-divided powders with an inert base, such as china clay, containing two to four per cent. of nicotine, and which are blown in the form of a mist through the orchards and hop gardens. Nicotine, therefore, in its various forms, is a valuable insecticide, and although from time to time scarcity and high price have caused substitutes to be sought and boomed, its freedom from damaging plant-life has led to increased and wider use in horticulture and agriculture.

Methods of Manufacture.

The methods of manufacture of nicotine may be arranged under the following heads :—

(1) Removal from the raw material by *water*. This consists of the production of an aqueous extract, alkali being added before or after to free the nicotine from its combination with organic acids ; the removal of the nicotine from the aqueous extract by distillation in steam, and the subsequent acidification and concentration of the distillate to 40 per cent. sulphate, or, if the free alkaloid is required, decomposition of the resultant sulphate with alkali and recovery of the nicotine by a volatile solvent. In some processes, the aqueous extract is treated direct with a solvent such as petrol, from which the nicotine may be recovered by distillation, or as a salt by agitation with an acid.

(2) Direct removal from the raw material by *steam*. (*a*) The raw material, in almost dry condition, is treated with sufficient alkali to decompose the nicotine salts. The plant used in this method is ingenious, especially that in which

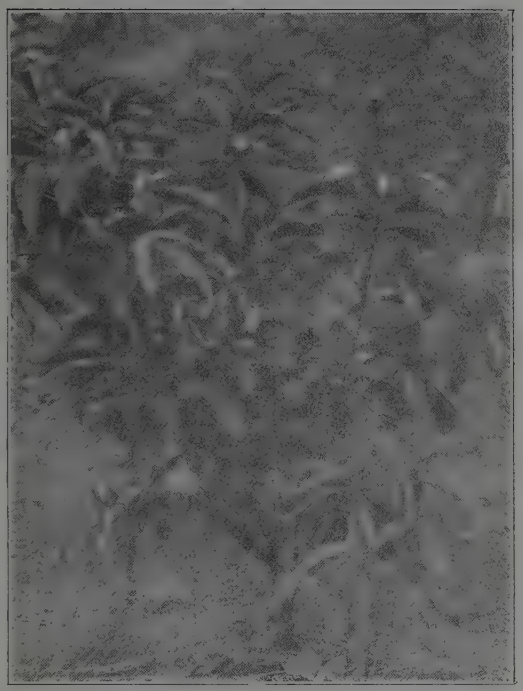

FIG. 5.— *A grafted avocado tree.*

FIG. 6.—*Florida grapefruit showing method of grease banding for protection against climbing insects.*

ACADEMIC STAFF AND STUDENTS, 1931-32.

Sitting left to right :

1st Row :—V. O. Ferrer, A. C. Suarez, A. Garces, B. de B. Darwent, C. M. Imamshah, H. L. Manning, J. de la Bastide, St. George Cooper, A. D. Herbert, R. Bally, J. M. Cave, T. E. K. Potter.

2nd Row :—W. A. Tansley, F. W. Urich, E. E. Cheesman, H. R. Briton-Jones, H. A. Ballou, G. Evans, R. C. Wood, C. Y. Shephard, G. A. Jones, P. E. Turner, L. A. Corbin.

Standing left to right :

1st Row :—D. W. Duthie, J. A. McDonald, F. J. Pound, J. G. Davies, D. D. Paterson, C. T. Watts, G. G. Gianetti, A. K. Briant, E. E. Pyke, A. Pickles, R. E. Hunter.

2nd Row :—H. C. Miller, N. Wright, A. M. Gwynn, B. C. G. Charles, P. C. Chambers, J. A. Rudderham, A. E. Moss, J. T. H. Stein, A. R. Foster, J. Singh.

3rd Row :—J. R. E. Hindson, C. L. Willding-Jones, M. L. Y. Israsena, S. A. Schouten, D. F. Ruston, W. B. Mason, B. R. Jones, H. Gillman, F. B. Wilson, J. D. E. F. Vesey-Fitzgerald, J. J. Anderson, J. T. Moon, J. Gordon, E. J. Gregory, L. de Verteuil, G. R. J. Murray, G. C. Stevenson.

4th Row.—A. Jones, J. M. McEwen, M. Barcant.

Absentees.—F. Hardy, C. W. Wardlaw, L. P. McGuire, J. G. Myers, H. V. Metivier, J. R. Dickson and A. V. Richards.

the finely divided dust is maintained in suspension by paddles in a trough-like container whilst steam at the most suitable pressure and temperature is blown through in a counter direction, to be eventually condensed and treated for the recovery of nicotine. (*b*) To the finely ground raw material sufficient water containing an *alkali* is added so that it will flow down a special bell and plate column, such as is used in the recovery of ammonia. The nicotine-laden steam issuing from the top of the column is led into hot sulphuric acid solution to form the commercial 40 per cent. sulphate. This method has been patented.

(3) *Destructive distillation*, which is only practised in the United States of America, and probably employed in the case of low grade raw material, including the mid-rib, is carried out in tall retorts with carefully regulated access of air, so that a zone exists where the nicotine is dissociated from the organic acids with which it is combined in tobacco. The nicotine passes forward with the current of air, and is trapped by acid or other means. Those who have studied or have had experience of wood-distillation will realize that the yield will be poor and the recovery difficult, in view of the numerous by-products.

World Production.

The quality of nicotine produced throughout the world is difficult to estimate, as the statistics do not differentiate between tobacco extract, nicotine sulphate (40 per cent.), and nicotine (95 per cent.), but probably the total quantity does not exceed 500 tons per annum. This figure, which must be accepted with great reserve, gives a rough indication of the magnitude of the trade which is comparatively very small.

CANE MOTH BORER.

Control of Cane Moth Borer in Barbados.

An Example of Co-operation.

In the November issue of *Tropical Agriculture* (Vol. VIII, No. 11) an article by Mr. R. W. E. Tucker appeared, giving full details of the mass rearing and distribution of *Trichogramma minutum* for the control of *Diatraea saccharalis* in Barbados. The results obtained since the commencement of mass parasite breeding and liberations in 1929 were summarised and, in spite of a set back due to the drought of 1930, reduction of infestation was sufficient to warrant an expansion of the work.

It has always been realised that the output of parasites was insufficient to control the pest over the whole island, but that until definite results had been shown, an expansion of the output could not be undertaken.

In the article just published, an outline was given of an estimated adequate output although it was realised that in these days of drastic curtailment of Government expenses, the carrying out of the scheme by the Department of Agriculture was out of the question.

It is, therefore, gratifying to record that the Planters of the island—who should have some realisation of the efficacy of the control after three years' observation—have agreed to raise and donate to the Government of Barbados sufficient money to erect, equip and run four or possibly six more moth units, and to provide the working expenses of these additional units, &c., for a period of two years.

The suggestion outlined in the article just published will, therefore, now become fact, and the work of erecting the new units has already been started.

This will increase the output of parasites from over 40-million a year to between 80 and 90 million, or if six new units are built, to around 110 million parasites. The real efficacy of the mass production and early and continuous distribution of *Trichogramma* can now be fully demonstrated; that it is an economic measure is proved by the figures given in the article mentioned, and the ease and steady routine of running what is certainly the largest outfit of its kind in the Empire—and in its extended capacity probably anywhere else—can be vouched for by anyone who has seen the existing equipment in full operation.

Mr. Tucker states that he considers this extensive use of mass reared *Trichogramma* only as an economic measure best adapted in his opinion and experience to the control of *Diatraea saccharalis* in sugar-cane, under the biological and ecological conditions existing in Barbados. As other writers have pointed out, these conditions, and the pest-plant relations, differ widely even in the West Indian region and Mr. Tucker considers that control of cane moth borer elsewhere, would not, in many cases, necessarily be parallel with the above; the effective use of *Trichogramma* is probably limited, as is the case with all other control measures, biological or otherwise.

The example of the planting community in Barbados in voluntarily subscribing the capital and running expenses for the enlarged production described is, however, an acknowledgment of their belief in the efficacy of this type of control in Barbados, and an example of co-operation which may well be taken note of.

THE PAPAW.

It has been brought to our notice by the Commissioner of Agriculture that the tropical fruit *Carica papaya* is often erroneously referred to as pawpaw. The proper common name for this fruit is papaya or papaw. The pawpaw is the fruit of a sub-tropical tree, of the same family as the soursop and custard apple, and, as an edible fruit, has no resemblance to the luscious tropical papaw.

NOTE.

Owing to pressure on our space we were unable to include in this issue the article "Maize in Kenya" as announced on the cover.

CHEMICAL NOTES.

Compiled by the College Department of Chemistry and Soil Science.

Vitamin C in the Orange and the Grape Fruit.

Bracewell and Zilva determined the antiscorbutic activity of (*a*) the Jaffa orange picked from the same trees at different times of the season during two consecutive years, (*b*) the Marsh and Duncan varieties (British Honduras) of grape fruit also picked at different times of the season during two consecutive years, and (*c*) the Marsh and Florida varieties (South Africa) of grape fruit picked at the end of the season.

Within the limits of the doses tested and of the accuracy of the method employed, the vitamin content of the juice is the same whether the orange or grape fruit is picked at the beginning or at the end of the season. There is no marked loss in the vitamin content when the fruit is stored under ordinary conditions at 15° for about two months. The conditions of cultivation, origin of stock, age of tree, soil, &c., do not affect the vitamin C content of the fruit.

Taking all the available information into consideration, the authors believe that oranges and grape fruit bought casually in the open market under normal conditions ought to possess the full antiscorbutic value characteristic of these fruits. The vitamin C content of the grape fruit was found to be slightly higher than that of the Jaffa orange.—(*Biochemical Journal*, Vol. XXV, No. 4, 1931, p. 1081.)

* * *

Neutralizing Values and Rates of Reaction with Acid Soils of Different Grades and Kinds of Liming Materials.

This investigation consists of a study of the reaction, after various periods of time, of ground limestone, crushed oyster shell, and basic slag of different degrees of fineness, with soils in greenhouse pots, especially as influenced by the hydrogen-ion concentration of the soil. The results may be briefly summarized as follows :

(1) The greater the H-ion concentration of the soil, or the greater the avidity of the acids, the higher is the rate of reaction of liming materials with it.

(2) The finer the liming materials added, the quicker will the soil acids be neutralized.

(3) Ground limestone coarser than 20 mesh is very slowly reactive. With medium acid soils it gave a value of about 20 after two years as compared with a value of 100 for precipitated very fine calcium carbonate, and with an extremely acid soil, the value was 37 after one year.

(4) The 20 to 60 mesh limestone gave values on the medium acid soils after two years of about 60, whereas with two very acid soils it gave values of about 88 after one year.

(5) Crushed oyster-shells gave about the same neutralizing values as ground limestone of similar grades of fineness, although coarse grade shells seemed slightly less effective than coarse grade limestone.

(6) The neutralizing value of the ordinary basic slag as measured against boiling 0.4 N HCl was found to be completely effective in neutralizing the acidity of a very acid soil. With the medium acid soils, however, it was found that after two years only about 80 per cent. of the potential neutralizing value of basic slag is effective.

(7) The low grade basic slag, which contains considerable coarse material, was found to be much less reactive than the finer, ordinary basic slag. On the basis of equal potential neutralizing value, it was found to be about 80 per cent. as effective as the latter.

(8) The use of ground limestone and crushed oyster shell coarser than 20 mesh was effective in neutralizing some of the acidity developed by the use of ammonium sulphate fertilizer.—(W. H. Pierre, *Soil Science*, Vol. XXIX, No. 2, 1930, Abstract *Proc. Intern. Soc. Soil Sci.*, Vol. VI., No. 3, 1931, p. 94.)

* * *

Saccharification of Wood.

In a communication to the Society of Chemical Industry on 1st November, Drs. H. A. Auden and W. P. Joshua described a process for the transformation of wood cellulose into fermentable products on an industrial scale. With an improved method they have succeeded in obtaining thirty-five to forty gallons of alcohol per ton of dry sawdust. This makes the process commercially profitable where the cost per ton of dry sawdust is not more than five shillings and a supply of 200 tons per twenty-four hours is available. The method was worked out in the Research Laboratory of the Distillers' Company, Epsom. It consists in forcing acidulated water (containing two parts per thousand of sulphuric acid), at a temperature of 180°C. and twelve atmospheres pressure, through sawdust packed in lead-lined vessels. Under these conditions 45-50 per cent. of the sawdust is changed into fermentable sugars. The molasses thus obtained are fermented with yeast in order to obtain alcohol. A preliminary treatment of the sawdust with superheated steam has been found advantageous, because it removes resins and other undesirable constituents and also helps the hydrolysis.—(*Nature*, Vol. CXXVIII, No. 3242, 19th December, 1931, p. 1045.)

* * *

Chemical Composition of Avocado Seed.

Weatherby and Sorber have made quantitative determinations of the composition of the seed of the avocado (both Mexican and Fuerte varieties) including moisture, ash, acidity, nitrogen, protein, reducing sugars, sucrose, starch, pentosans, crude fibre, and ether extract. They find that the seed is made up largely of water, starch, sugar, and protein, with but a small amount of crude fibre. There is a possibility of its use as a food product or feeding stuff, though the small amount of bitter-astringent principle present might have to be removed.

Perseit (α – d – Manno heptite) might figure as a by-product if a use for it could be found. (*Ind. and Eng. Chem.*, Vol. XXIII, No. 12, 1931, p. 1421.)

SUGAR NOTES.

Compiled by the College Department of Sugar Technology.

Quarantine and Leaf Scald Disease of Sugar-Cane.

Owing to the tendency for symptoms of Leaf Scald to remain latent in infected cane for long periods, especially in the more resistant varieties, it will be desirable, according to Mr. S. F. Ashby of the Imperial Mycological Institute, to adopt special measures against this disease in passing introductions through quarantine in the tropics. It is probable that a period of one year in a glasshouse may suffice to detect and eliminate other diseases (Leafstripe due to *Sclerospora sacchari* Miy. perhaps excepted) but this period is not likely to be enough to exclude Leaf Scald.

Mr. A. F. Bell, Sugar-Cane Pathologist to the Bureau of Sugar Experiment Stations, Brisbane, Queensland, in a letter received recently, states that on hearing of the quarantine methods adopted in the Hawaiian Islands (similar to those used at Washington, D.C.) he wrote to the Director of the Hawaiian Sugar Planters' Association Station about 20 months ago that such measures would not exclude Leaf Scald and that it might be expected to appear in Hawaii at any time. Mr. J. P. Martin, Plant Pathologist to the Hawaiian Sugar Planters' Association Station, recorded Leaf Scald for the first time this year as definitely present in those islands ('Diseases, Malformations and Blemishes of Sugar Cane in Hawaii,' *Hawaiian Planters' Record* 35, No. 2, April, 1931).

Mr. Bell mentions that in Queensland there are two periods when one may have most success in finding symptoms of Leaf Scald:

1. In young plant cane during the dry period of late spring or early summer.
2. In the mature cane during dry, cool winter weather. This appears to have been also the experience of Mr. Shepherd in Mauritius.

It would appear to be desirable, after the introductions have been grown for a year in a glasshouse, to plant them in an isolated place in the open at the right time, so that the young cane and eventually the mature cane may meet with the conditions favouring the expression of symptoms of the disease.

Leaf Scald occurs at present in: Queensland, New South Wales, Fiji, New Guinea, Java, Philippines, Formosa, Mauritius, Reunion, Hawaiian Islands, Porto Rico (doubtful), P.O.J. 2878 has been found somewhat susceptible to the disease in Java, Formosa and Mauritius.

* * *

Bagasse Utilization: For the Production of a Cheap and Effective Plastic.

A very simple method of making a moulded product has recently been patented in which use is made of cheap cellulosic materials as sawdust or bagasse. This is treated so as to liberate the binder in it, which is precipitated upon the separated fibres. It thus forms a cheap, mouldable composition.

Thus, for example, 6 lb. of sawdust or bagasse, 2 lb. of caustic soda and 1 gallon of water are placed in a digester and treated with steam at about 160 lb. pressure for 3 to 4 hours. About 3½ lb. of concentrated sulphuric acid in 3 to 4 gallons of water are next added. This precipitates resinous products. The mass is filtered and washed until the filtrate is neutral and free from sulphate. After drying in the air at about 80°C., an alkaline substance (*e.g.*, 3 per cent. of lime) is added and the product thoroughly mixed in a ball mill or tumbling barrel, or otherwise to form a powdered compound ready for moulding.

This compound is placed in moulds and subjected to heat and pressure. Under these conditions certain constituents of the mixture become plastic and the material flows taking the exact shape of the mould. Usually in a few minutes, the mass becomes hard and infusible, but the moulded article may be removed from the mould while hot without distortion. Such moulded articles are hard, strong and smooth, and are not affected by atmospheric moisture. They may be moulded into various desired forms, and the colour can be varied by the addition of suitable dyes or pigments before moulding. Various fillers or strengthening agents may likewise be added before moulding.

Here then is a method of utilizing bagasse that may be of great interest. It is invented by Frederick H. Smyser, of Marblehead, Mass., U.S.A., and covered by him in United States Patent 1,794,254, which is assigned to the General Electric Company. Such a process should not require any very costly plant, and should be easy and cheap to operate. It could be applied on the plantation for making blocks and boards and the material moulded could no doubt be rendered rot-and-insect proof by suitable additions. —(*Int. Sugar Jr.*, Vol. XXXIII, No. 396.)

* * *

Mechanical Cane Harvesting in Florida.

Fourteen Falkiner cane harvesting machines cut between 90,000 and 100,000 tons of sugar cane on the fields of the Southern Sugar Company of Florida under difficulties of soft ground and tangled cane. This is the first instance of a full cane crop being taken off the fields by mechanical means. The best performance of a single machine was 265 tons in two 10-hour shifts; in green lodged cane with a heavy accumulation of trash the machines handled about 150 tons a day; where the cane is reasonably straight and clear the harvester cuts about 20 tons per hour. A harvesting crew comprises a driver for the harvester, a driver for the tractor which hauls the cane cart, and one assistant. Lubrication cost is about 10 per cent. of the fuel cost.—(*Facts about Sugar*, Vol. XXVI, No. 10.)

TREND OF THE MARKETS.

[*The notes below are based principally upon running charts of the prices of the basic grades and upon general statistical information gleaned from contemporary publications and cablegrams and are intended to be a record of movements. An attempt is made, where possible, to indicate the market outlook at the time of going to press, but no responsibility for the accuracy and subsequent truth of such observations is assumed. Unless otherwise stated the prices quoted are spot, London.*]

SUGAR.—Prices on the Home Market have ranged as follows (c.i.f. per cwt.) :—

	Foreign.		*Preferential.*	
	s.	*d.*	*s.*	*d.*
3rd December ..	6	$7\frac{1}{2}$	10	$4\frac{1}{2}$
10th December ..	6	$9\frac{3}{4}$	10	$6\frac{3}{4}$
17th December ..	6	$9\frac{3}{4}$	10	6
24th December ..	6	9	10	6
31st December ..	7	$0\frac{3}{4}$	10	$9\frac{3}{4}$
7th January ..	7	0	10	$9\frac{3}{4}$
14th January ..	7	$0\frac{3}{4}$	10	9
9th Jan. (1931)..	6	3	9	$4\frac{1}{2}$

There has been little activity in the markets during the past month. According to *Messrs. Czarnikow Ltd.*, the decline in the absorption of sugar, particularly noticeable in America and the Middle and Far East has led to a slowing down of exports of Cuban sugars to the United States of America and a serious decline in the shipments from Java to her regular markets. It has, therefore, become increasingly apparent that some adjustment of production will take place to conform with the altered statistical situation. This state of affairs is being considered by the Paris Conference, the results of whose deliberations are likely to affect the future trend of values. *Willett and Gray's* estimate of the world crop of cane and beet sugar revealed a reduction of no less than 2,735,000 tons.

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COCOA.—During the past month cocoa prices registered an almost uninterrupted decline. The latter was at first solely caused by a further depreciation of the Pound Sterling, and as a matter of fact cocoa prices did not decline as fast as that currency. Subsequently, although Sterling improved, cocoa continued its downward trend due to heavy hedge selling against West African offers. Whilst a continuance of the universally prevailing economic depression must be reflected in low commodity prices, sight must not be lost of the fact that there is a limit to a decline even under the worst conditions conceivable. During the period under review the price of Accra cocoa was quoted at 28*s.*, 29*s.*, c.i.f., and $8.00 a fanega is freely paid locally for Plantation cocoa.—(*By courtesy of the Cocoa Planters' Association of Trinidad, Limited.*)

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BANANAS.—Jamaicas continue in fair demand at the unchanged price of £20 5*s.* per ton delivered London, and £20 delivered nearest railway station. Brazilians remain at £18 per ton delivered nearest railway station and are in fair demand.—(*West India Committee Circular*, 24th December.)

COTTON.—The following are the official spot prices in pence per lb. of the Liverpool Cotton Association :—

	American Mid.	*Egyptian F.G.F. Sakel.*	*Sea Island.*		
			Good.	*Extra fine.*	*Prices paid this Week.*
4th Dec.	5·14	7·20	—	—	—
11th Dec.	5·21	7·30	—	—	—
18th Dec.	5·20	7·20	—	—	—
23rd Dec.	5·29	—	—	—	—
2nd Jan.	5·39	—	—	—	—
8th Jan.	5·33	—	—	—	—
15th Jan.	5.41	—	—	—	—
9th Jan. (1931)	5·40	—	—	—	—

Prices have shown only slight fluctuations and business has generally been quiet. The Bureau reports a crop of 16,918,000 bales, but the market is much more interested in consumption prospects. Sea Island is quoted as follows : good fair 5.60*d.* ; good 6.10*d.* ; fine 6.85*d.* ; extra fair 7.35*d.*

* * *

RUBBER.—Quotations for Plantation Sheet have ranged as follows :

	d.
2nd December	$2\frac{15}{16}$
9th December	3
16th December	3
23rd December	$3\frac{3}{16}$
30th December	$3\frac{3}{8}$
6th January	$3\frac{3}{16}$
13th January	$3\frac{1}{8}$
7th Jan. (1931)	$4\frac{3}{16}$

The market which at first only showed slight fluctuations developed a rather firmer tone towards the end of December, following an impending announcement that the British and Dutch delegates were approaching an agreement in regard to restriction. The need for a prompt decision is urgent as the statistical situation is rapidly becoming worse.

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FERTILIZERS.—

	Prices.					
	A year ago.			23rd Dec.		
	£	s.	d.	£	s.	d.
Sulphate of Ammonia (20.6% N.) .. delivered ..	9	5	0	6	15	0
Sulphate of Potash ..(48% K.)—f.o.r...	12	2	0	12	0	0
Muriate of Potash ..(50% K.)—f.o.r...	10	0	0	9	16	0
Super-phosphate ..(14% Sol P_2O_5)—f.o.r.	2	17	6	2	12	6

—(*The Fertilizer, Feeding Stuffs and Farm Supplies Journal*, 23rd December, 1931.)

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LIME PRODUCTS.—*Lime Oil.*—Handpressed is slow of sale and valued nominally at 60*s.* per lb. Rather heavy arrivals of Distilled and an absence of demand are depressing the market.

Lime Juice.—The value of Concentrated is unchanged at £5. Raw is neglected.—(*West India Committee Circular*, 24th December.)